HEALTH READER

PHYSIOLOGY-HYGIENE

WILEY

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By

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RAND McNALLY & COMPANY

CHICAGO NEW YORK

A FOREWORD

I believe it was George Ade who said, "If you want to uplift, get beneath." This sentiment is peculiarly applicable to the study of physiology in the schools. Such terms as "anatomy," "physiology," and "hygiene" terrify the children, and to a certain extent make them antagonistic to the study. I have long thought that the proper way to get children interested in this matter was to make the subject a living one. I have sought to get entirely under it and to present it in a vital way. My experience is that children are easily interested in matters that pertain to their daily life if we go at it in the proper spirit. Instead, therefore, of the dry details of physiology, I have tried to lead the child into the midst of the phenomena of the life he is living and to tell him in simple language of the character of the environment in which he lives.

I begin by taking him outdoors and allowing the wind to blow in his face. I lead him to the fireplace and let him warm his fingers. I take him to the spring and show him the water that he drinks. I go with him into the fields to watch the food he eats grow. I carry him into the mills where the food is prepared for consumption. I tell him of those things which are vitally related to his daily life and which are the groundwork of his health and growth. I have endeavored to put the material into the form in which the child naturally absorbs it. The child is an interrogation point. He asks questions. I have taken the questions which have been suggested to me by talking with children, and have tried to answer

the questions they have put to me. While this method of preparing a physiology is novel and radical, to my mind it seems natural and workable. With the help of the teacher the child will at once become interested in the phenomena of existence. The study will not be a burden, but a revelation and a pleasure.

While it has seemed advisable in some places to use words which children do not understand, their meanings have been given so that they may know what they are reading about. The dry details of the usual form of study on this subject have been entirely eliminated. The child who reads this book properly under competent instructors will have a new view of life, a better understanding of his environment, and a clearer conception of what is good for his health. He will be asking himself continually, when new duties and new pleasures present themselves, or new foods come to his attention, this question: Is it good for me?

HARVEY W. WILEY

Washington, D.C.
April, 1916

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HEALTH READER

PART ONE

I. The Air We Breathe

What is the air? The air is an invisible gas, without taste or smell. It covers the whole surface of the earth and enters into every hole and crack in the ground. It also enters the ground itself, finding its way to a great depth between the particles of soil.

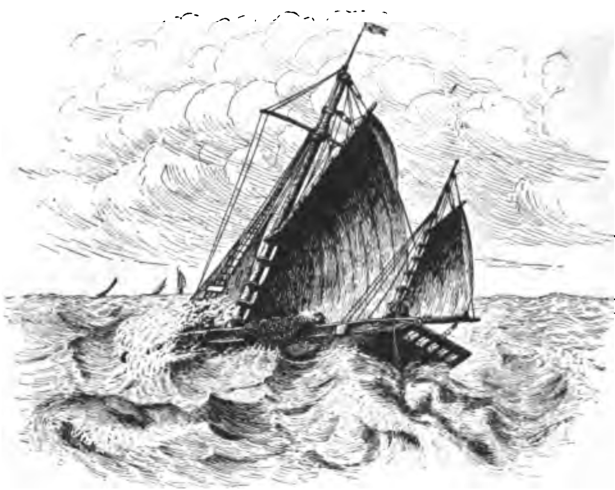
You have felt the wind blow in your face, have you not? Once, perhaps, your cap was carried away by the wind, and you ran after it as fast as you could. The same wind that carried away your cap raised such a cloud of dust you could hardly see the cap. Fortunately it struck against a tree or fence, or against the curbstone,

A lively chase

and you captured it, breathing deeply and quickly as a result of your chase.

What is the wind? Wind is air in motion. Perhaps in a violent wind storm you have seen a tree blown down, a house unroofed, or a signboard blown into the street. If you live near water you have watched the sailboats driven swiftly through the water, and you have seen the high waves crested or white with spray. What is it that drives the boat? What produces the waves? It is the wind.

What becomes of the wind when it stops blowing? When it stops blowing, the wind, which is air in motion, becomes still air, or air at rest. Have you looked at a pond of water?



A sailboat being driven swiftly through the water by wind

There you see water at rest. Have you seen a creek or a river? There you see water in

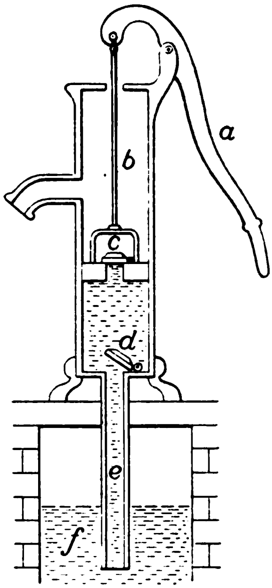
A pond and a creek, showing water at rest and in motion

motion. We say that the water in the creek is flowing. The wind is flowing air.

Why can we not see the air? We cannot see the air because it has no color. But we can feel it. Move a fan slowly — you feel no resistance. Move it rapidly — you feel you are pushing it through something. That something is the air. The fan moves the air out of the way and sets it in motion. That makes the wind. You feel the wind against your face, but you cannot see it.

Has the air weight? Yes, it is quite heavy. Put one end of a tube or straw in a glass of

water. Then suck the air out of the tube. The pressure of the air on the water outside of the tube will drive the water into your mouth. The common water pump is such a tube. You take the air out of the tube of the pump by working the pump handle. The air pressing on the water in the well drives it into the tube as fast as the air is removed from the tube.



A well pump

a, handle; *b*, piston; *c*, valve in piston; *d*, valve at top of suction pipe *e*; *e*, suction pipe to water well *f*; *f*, water in well

You can easily make a little pump. Take any tube—a glass one is best, because you can see through it. Now make a plunger by wrapping the lower end of a stick with a string until the plunger fits snugly in the tube. Place the end of the tube in a glass of water and draw the plunger up slowly. By doing this you lift the air out of the tube. If the plunger fits so that the air does not leak, the water will rise in the tube and keep in touch with the end of the plunger. You do not lift the water. You lift the air in the tube. The pressure or weight of the air on the water

outside of the tube forces the water into the space in the tube from which you lifted the air.

A homemade pump for demonstrating the weight of air
p, piston

What happens if the lower end of the tube is closed? This you may easily discover. The plunger prepared as described is generally called a *piston*. Oil the piston head, that is, the end that fits tightly in the tube, so that it works easily. Place your finger over the end of the tube so as to close it tight. Then try to draw up the piston. You will find this very difficult to do. Why? Because you are lifting the air. You will also find that your finger is held firmly pressed against the end of the tube.

II. The Elements of the Air

What is air? You have learned that air is an invisible gas without taste or smell. You can feel it, you can measure it, you can weigh it, and you have seen what it can do when in motion. Now all will want to know what this gas called air really is.

What are the forms of matter? All the forms of matter with which we are familiar are of three classes: solid, liquid, and gaseous. A solid body, as we all know, sticks together, holds its form, and can be fashioned or made into various shapes. A liquid body, on the other hand, holds its form only if held together by the walls of a container or vessel, as water in a cup. Pour water into a cup until it is full. If there is a hole in the cup it will not stay full, for the water will at once begin to run out of this hole and will keep running out until the cup is empty.

Rocks and pool. A solid and a liquid body

If you look at water or any other liquid in an

open vessel you will find that the top of it is always level. Now what is it to be level? That seems a simple question, and yet it is a very important one. To be level, a surface must fit exactly with the surface of the earth, if the earth were perfectly smooth; that is, if there were no hills, no hollows, no river beds, no sea beds on it. The free surface or upper surface of a liquid is always level, and it is so because of the flowing nature of the liquid itself.

A pail of water, showing the level surface of a liquid

What are the differences between a solid, a liquid, and a gas? All the surfaces of a solid are limited. The top surface, the side surface, and the under surface, all are unchanging or constant and limited, just as a block is always the same size and shape no matter where it is. A liquid has only one surface limited—that is, its upper surface. A gas has no surface limited; it moves in all directions. Air is a gas.

By what means can you discover how the air acts? You can discover this only by observing a gas that has a color. Air has no color, so air cannot be used for your experiment. There are gases, however, that have colors, and by means of these colored gases we can see how the

air acts. Place a small quantity of a colored gas in an empty vessel from which all the air has been drawn out so as to form what we call a *vacuum*. If this vessel is of glass so you can see into it, you will observe that almost instantly the gas will fill all parts of the vessel. Water will run only downwards; a gas will run in every direction.

A barometer

How far upward does the air extend? No one knows exactly. No explorer who has climbed high mountains, no aviator who has reached high altitudes in balloon or aëroplane, has been more than three or four miles above the level of the sea. Yet he still finds air there. But we do know that as we go up, the air gradually gets thinner, until somewhere, very far up, it ceases to exist.

If we climb a high mountain and carry with us a barometer, an instrument which measures the pressure of air by means of mercury in a glass tube, we find that the higher we climb the lower is the height of the mercury column in the barometer. The pressure of the air decreases because the higher we climb the more air we have below us, and the smaller the amount above us. When

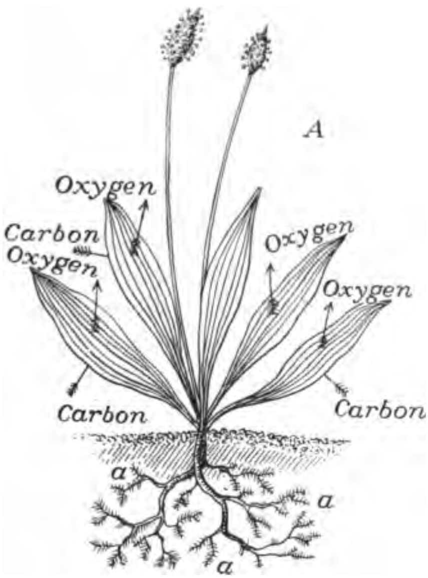
you reach the top of a mountain that is a mile high you notice that you breathe with more difficulty. If you breathe as you usually do at the lower level where you live you have a sense of partial suffocation. You find that you must breathe deep and fast in order to get enough air. When you go two or three or four miles high, breathing becomes exceedingly difficult, and at a still greater height life could not be sustained.

Of how many kinds of matter is air composed? This is a question of interest to every one. You do not need to be a chemist, or a physiologist, or any other kind of learned person to be interested in what makes up the air. You want to know whether the air is made up of several kinds of matter, or whether it consists of just one kind. If you put a marble and a lump of sugar and a bullet into the same box they may all be the same shape and the same size, but you know that you have more than one *kind* of matter in that box. Now we may suppose the air to be made up of spheres like marbles, except that they are so small it is impossible to see them.

Are these little particles all of the same kind? No, they are not. The great bulk of the atmosphere is made up of two kinds of little spheres, all mixed together so that you cannot detect any difference between the atmosphere in one place

and that in another. About four fifths of the air is made up of little particles of a gas called *nitrogen*, and about one fifth of it is made up of little particles of another gas called *oxygen*. Then there are many particles of other substances scattered around among these, but not in very great quantities.

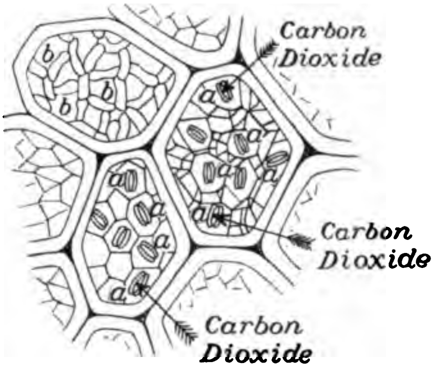
If you drop a little acid on a piece of limestone you will see an effervescence or a bubbling, and a gas will escape. That gas is called *carbon dioxide*. It is the same gas that is formed in the body when food is burned to make your body warm. For, just as wood or coal is burned in a stove to keep the house warm, so a portion of the food we eat is burned in the body to keep it warm. This gas also forms when anything is burned by fire. Particles of this gas are



A—How plants breathe
a, root hairs which absorb soluble mineral substances from the soil

always present in the air. There are about four parts of this gas to ten thousand parts of air. It has important work to do. It is necessary in the growth of plants. The plant takes these little particles of carbon dioxide gas, invisible to us, and uses them to form woody fiber and sugar and starch. But the plants do not use the carbon dioxide particles entirely. These particles consist of a compound or mixture of carbon and oxygen. The plants take only the carbon contained in the particles, the same substance you see in coal and in diamonds. After separating the carbon from the carbon dioxide particles, the plants send back the oxygen into the air. Thus there is a continual contest going on in nature. The fires that burn in the stoves and furnaces, the breath that comes from the lungs, and the gas that comes from the burning gas jet or lamp are continually taking oxygen from the

B



B — Under side of leaf as seen from a microscope

a, mouths or stomata; *b*, leaf cells

air and throwing little particles of carbon dioxide back into the air. But the plants are continually taking these particles of carbon dioxide, absorbing their carbon, and turning the oygxen back into the air. Thus the air always contains oxygen sufficient for all the purposes of life. Because of the action of plants on the carbon dioxide in the air, house plants are useful and healthful.

There are also little particles of water in the air. You don't usually think of water as a gas, yet water exists everywhere as a gas. As a rule you cannot see it, but when so much of it goes into the air that it forms a cloud or a fog, then of course it may be seen. Although as a rule you cannot see water in the air, it is there, and in very considerable quantities.

There are also a number of other substances in the air which learned men never thought of until within the last few years. These substances have been discovered very recently. The air is like the world. For a long time people did n't know there was such a continent as America. Until a short time ago no one had ever seen the earth at the poles. We are continually making discoveries in the earth's surface. We are also making discoveries in the composition of the atmosphere. One of these is the discovery of *argon*. If we could see all

the different particles present in the air we should find little particles of argon. Argon is a Greek word meaning "inactive," and it is applied to these particles because they are extremely inactive. Argon particles do not form close acquaintanceship with the particles of any other gas. They like to stand off in a corner by themselves.

Then again we should see, if we had the right kind of eyes with which to see, that there are still other little particles wandering around in the atmosphere. These are called *krypton*, a word which means "hidden," and applied to these particles because they had been so long concealed that nobody even knew they existed. We should see still other little particles, not so numerous but nevertheless quite abundant, called *xenon*. This word means "stranger," and was applied to these particles because it was so long before anybody made their acquaintance.

All of these substances make up the atmosphere we breathe, and none of them is in any close combination with any of the others. It is just a simple mixture. Every time you breathe you take into your lungs a certain amount of this mixture made up of all these substances. They are what are called *natural constituents*, or parts of the air. The air is pure when it

contains these natural constituents in the quantities in which they naturally exist in the great ocean of air surrounding us.

When is air impure? The air is impure when it contains too much or too little of any one of its natural constituents. For instance, if oxygen, which is the most active substance in the air and the one on which our life functions depend, is diminished in quantity the air is impure. If, on the other hand, oxygen is increased in quantity the air is also impure. If the quantity of oxygen is decreased, then we have to take in a great deal more air to perform the functions of life; if it is increased the burning of the foods and tissues in the body would go on more rapidly and we should become ill and have fever. If there were no oxygen in the air we could not live; also, if the air consisted entirely of pure oxygen it would speedily cause us to die.

The air is impure if unnatural and noxious or harmful substances are present in it. If you approach a gas factory you will smell an odor due to the presence in the air of little particles of bad-smelling gases. If you go near a refrigerating or ice-making establishment you are likely to notice an odor of ammonia which has escaped from the condensing machinery. If you happen to be in Chicago, especially when

the weather is warm, you may distinguish the odor of the stockyards at a distance of a mile or more from them if the wind is blowing from that direction toward you.

The air often carries in this way not only particles of gaseous matter which have a bad odor, but it may also contain gaseous particles having a pleasant odor. The odor of

A hayfield in midsummer

new-mown hay is familiar to all who live in the country. Everybody has been told about it or has read poems about it. The scent of the rose and the odor of the cornfield and the smell of the forest are familiar to almost every one. Various perfumes owe their power to the fact that they fill the air with small particles of

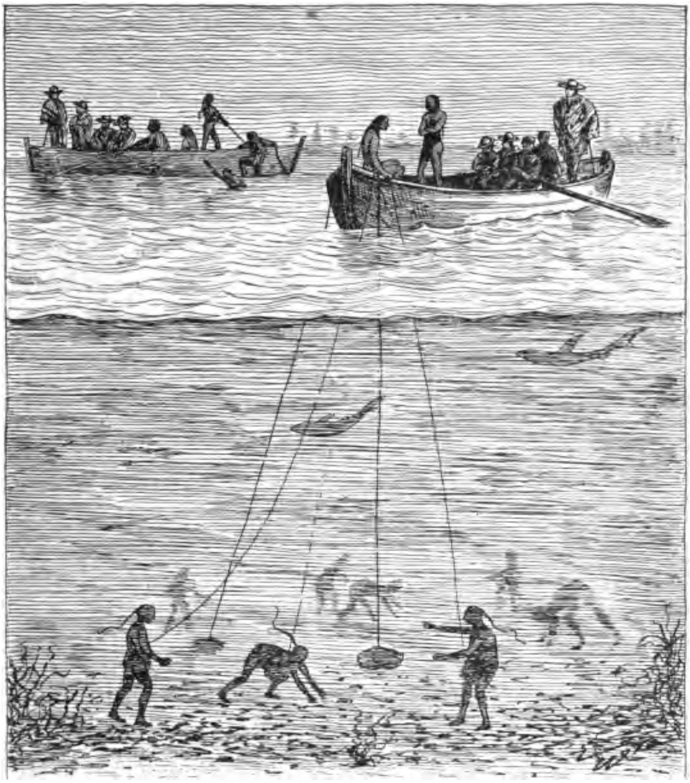
good-smelling material. The attar of roses, the *eau de cologne*, and all the various perfumes which a young lady puts on her handkerchief have these properties.

In our homes we are all familiar with the odors, generally pleasant, of the cooking dinner. Sometimes, though, these odors are unpleasant; for instance, when the odor of boiled cabbage or of frying fish fills the whole house.

All these instances illustrate the many substances which the air may contain, not to speak of the dust and solid particles which may also be present in the air. It is evident that the air is a very complex mixture, but this does not prevent us from fixing our attention on the fact that its chief characteristic, so far as human life is concerned, is its property of supporting life.

Can we live without air? Most of you have heard of the dreadful accidents in which drowning and suffocation overtake the unfortunate. These terrible examples illustrate the fact that we can live only a few minutes without air. If you try to hold your breath, you experience no discomfort for the first few seconds. But no matter how strong the will power may be, no one can hold his breath long enough to kill himself. Nature asserts her supreme authority over the will of the individual.

Divers who have practiced for a long while



Pearl fishers and divers at work off the coast of Ceylon

have been known to keep their heads under water for several minutes. This is possible, however, only to persons with great lung capacity, and who have filled their lungs full of air before submerging their heads in the water. Such rare examples, however, cannot be regarded as a measure of the length of time we

can do without breathing. Air is a constant, necessary, and indispensable element of life.

What takes place during the process of breathing? The process of breathing is a simple, mechanical action, involuntary as a rule, by means of which the lungs are filled with air. It is easy to breathe purposely, but as a rule breathing is wholly involuntary. We are asleep about one third of our time, and during sleep we are wholly unconscious of breathing. Unless we are taking exercise or purposely turn our attention directly to it, the act of breathing is just as unconscious during our waking hours as it is during sleep.

How often do we breathe? There is no rule by means of which we can measure the frequency of breathing. It varies greatly in different individuals and at different ages. When we are at rest, we do not breathe nearly so frequently as when engaged in active exercises. In ordinary circumstances, that is, when working at his ordinary occupation, the grown person will breathe about eighteen times a minute. Children breathe more frequently than grown persons, and old persons also breathe more frequently than people who are in the prime of life. Sickness also causes a difference in the rate of breathing. Usually the more severe the disease, the more rapid the breathing.

Especially is this true in diseases of the heart and the lungs.

How much air do we breathe at one time? This too can be answered only in a general way. The amount of air which is taken at each breath depends upon the size of the lungs of the individual and the way he uses them. If we practice deep breathing—that is, if we make a conscious effort to fill the lungs as full as we can—we soon acquire an unconscious habit of deep breathing, thus increasing the capacity of the lungs. The purpose of certain gymnastic exercises is to increase the lung capacity. This is true especially of exercises of the arms and shoulders combined with deep breathing. Such exercises increase the capacity of the lungs. When the lungs are diseased, as in tuberculosis and pneumonia, their capacity is diminished, and therefore the frequency of breathing is increased.

A grown person in good health, weighing one hundred fifty pounds, will generally take about a pint of air into his lungs at each breath. Children, naturally, take less, and the smaller they are the smaller the quantity of air they can take in.

What is the result if a person is deprived of fresh air? If a person were confined in a room ten feet square and ten feet high, in which there

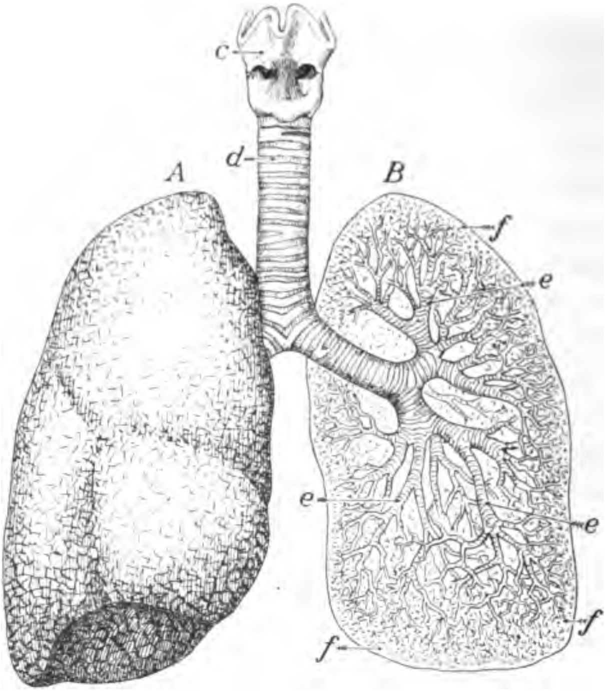
was no means of ventilation, the oxygen, which is the active agent in maintaining the heat of the body, would gradually be exhausted. The carbon dioxide, which is formed when the food and tissues of the body are burned, would be constantly increasing in quantity. Suffocation and death would finally result, although the end would come slowly.

III. The Organs of Breathing

What are the lungs? The lungs or organs of breathing are porous, vascular—that is, richly supplied with blood vessels. They are placed one on the right side and one on the left side of the cavity in the upper part of the trunk known to scientific men as the *thorax* but commonly called the chest. This cavity is formed chiefly by an inclosing structure of bones called the ribs. Leading to the lungs from the mouth and the nostrils is a tube called the *trachea*, known commonly as the windpipe. This tube divides into two branches, one going to the right lung and one to the left lung. These branches are called the *bronchial tubes*. An inverted tree excellently illustrates the character and appearance of the windpipe and the bronchial tubes. The trunk of the tree is the windpipe, and the roots are the openings into the mouth and the nostrils. The two main branches are the bronchial tubes. These tubes branch out into numerous smaller tubes like the smaller limbs of a tree.

The comparison may go still farther. In the lungs are numerous cavities or pockets, and these may be compared with the leaves of the tree. In fact, the tree absorbs air in a way that is a very good illustration of what takes

place in the lungs, except that the act of breathing goes on in inverse or opposite order. In the human body you breathe through the openings

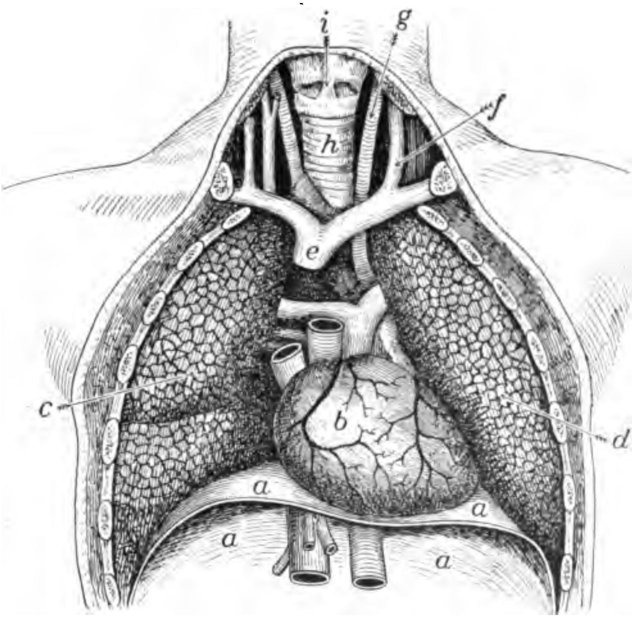


Lungs, showing larynx, trachea, and bronchial tubes
A, right lung, exterior; *B*, left lung, section view; *c*, larynx; *d*, trachea; *e*, small bronchial tubes; *f*, air sacs

of the windpipe and distribute to the branches and the lung cavities; the tree breathes through its leaves and distributes to the branches and the trunk and the roots. The human being takes in oxygen and gives off carbon dioxide,

but the tree takes in carbon dioxide and gives off oxygen. Thus the comparison is complete, although in inverse order.

The lungs are surrounded by a membrane or covering known as the *pleura*, and are located



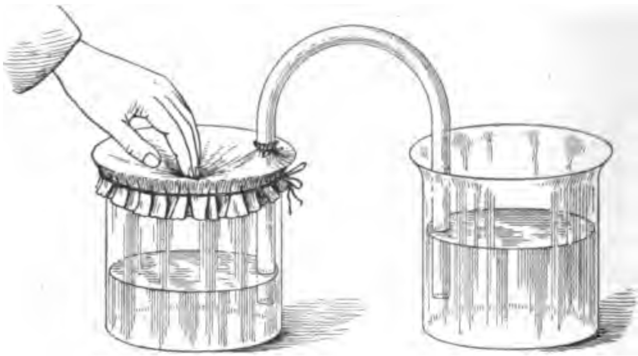
Trunk, showing diaphragm

aa, diaphragm; *b*, heart; *c*, right lung; *d*, left lung; *e*, superior vena cava; *f*, jugular vein; *g*, carotid artery; *h*, trachea; *i*, larynx

in the cavity inclosed by the ribs. At the back of this cavity is the backbone, or spinal column. At the bottom is a strong muscular cavity called the *diaphragm*. It is by the action of the diaphragm and of the muscles contracting and

expanding the ribs that the capacity of the thorax may be increased or diminished.

By the expansion of these muscles and the movement of the diaphragm downwards, the cavity or box in which the lungs are inclosed is increased in size and the air enters through the mouth and nostrils to fill this increased cavity. By the contraction of the muscles of the ribs and the movement of the diaphragm



Experiment illustrating breathing

upwards, the holding capacity of the cavity or thorax is diminished and the excess of air in the lungs is expelled. Thus breathing is brought about by the contraction and expansion of the thorax.

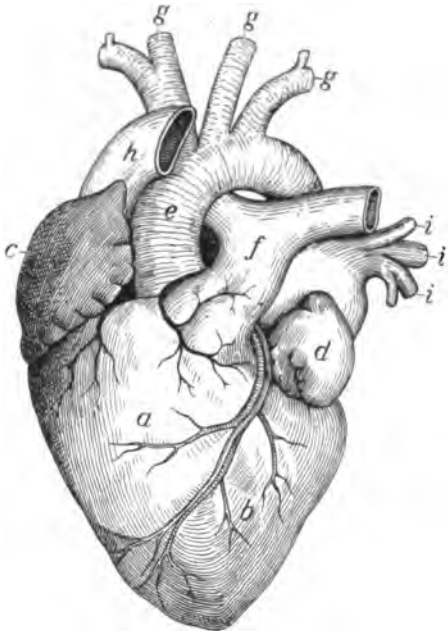
This can easily be illustrated by a simple experiment. If you cover the open top of a jar with a piece of rubber and press down on the rubber, you will diminish the capacity of the

jar. If you stop pushing and take your hand away the rubber will come back to its horizontal position and the capacity of the jar will be the same as it was at first. If you attach a curved tube to the jar and put one end of the tube in water you will find that when you push down on the rubber cover the air will be forced out of the jar through the tube into the water. On withdrawing your hand a portion of the water will be drawn through the tube into the jar. In this way you illustrate the mechanism by means of which breathing takes place.

What happens to the air when it reaches the little cells or pockets in the lungs? The cells of the lungs are provided with innumerable small blood vessels so arranged as to bring the blood into all parts of the lungs on its way to and from the heart.

The blood that enters the lungs comes from all parts of the body. On its way to the lungs the blood stream resembles a river system. Small vessels, so small as often to require a microscope to distinguish them, conduct the little globules of blood from the tissues in all parts of the body and pour them into larger vessels, and these into still larger vessels, until they reach the veins of the body. From these veins the blood finally finds its way into the great blood vessels or arteries that lead to the heart.

From the heart the blood passes to the lungs and is there redistributed through the same kind of small vessels in which it had its origin. These microscopic or very small blood vessels line the walls of the lung cells into which the air particles find their way. The blood stream is loaded with water and carbon dioxide derived from the burning of the food and the tissues of the body in all of its parts. When it comes into these little lung cells an interchange takes place between the oxygen of the air in the lungs and the carbon dioxide and the water in the blood. Some of the particles of carbon dioxide and water in the blood pass through the cell walls into the air



The heart, showing veins and arteries connected with it

a, right ventricle; *b*, left ventricle; *c*, right auricle; *d*, left auricle; *e*, aorta; *f*, pulmonary artery; *g*, branches of the aorta; *h*, superior vena cava; *i*, pulmonary veins

in the cells, and particles of oxygen pass through in a contrary direction from the air into the blood. In this way each little particle of blood is relieved of a load of carbon dioxide and water, after which each takes up a load of oxygen from the air. At the same time it changes color. As the blood, on its return from the tissues to the lungs, enters the little vessels in the lung cells it has a bluish tint. When it passes out it has a red tint. If you dress one little girl in a blue dress and another little girl in a red dress, and have the little girl in blue carry a lot of blue marbles and the little girl in red carry a lot of red marbles, and then have them exchange marbles and dresses, you will have an illustration of what is going on in the lungs. The little girl in blue represents the venous blood, or the blood in the veins, and the little girl in red the arterial blood or the blood in the arteries. The blue marbles are particles of carbon dioxide and water, and the red marbles are particles of oxygen. These exchanges are continually taking place in the lungs like innumerable millions of little girls dressed in blue and red exchanging dresses and marbles.

The little blood globules which have thus taken on a load of oxygen go to the heart and are sent again through the arteries to all the

tissues of the body. On this journey they give up their loads of oxygen and again take on loads of carbon dioxide and water, then start back through the vein capillaries on the way to the lungs and the heart. This process is constantly going on. Every few moments all the blood that is in the body passes through the lungs. It is also clear that the air that enters the lungs bearing its full quantity of oxygen passes out of the lungs bearing a full load of carbon dioxide and water.

Can we ever see the water in the air we breathe out of our lungs? Yes, it is not an unusual thing to see the water in the air we breathe out of our lungs. All you have to do is to go out of doors on a cold day and blow, and you will see what we call the steam or the fog of the breath. The cold air condenses the water in the breath and forms it into small particles or globules like a fog. Another easy way to prove that there is water in the breath is to breathe upon a mirror. The cold glass will condense the little particles of moisture in the breath so that you can see them.

Is there any way you can see the carbon dioxide in the breath? No, not exactly. It requires a very low temperature to condense carbon dioxide. It can be done, however, and the teacher of chemistry in the high school may show you frozen carbon dioxide. You may see it,

however, in an indirect way. If you will breathe through a glass tube into a little clear lime water, which you can easily make from a fragment of lime or which you can buy at the drug store, you will soon see the whole mass of water become white. But these little particles you see are not carbon dioxide. They are particles of carbonate of lime, the same thing as limestone or marble. This carbonate of lime is formed by the union of the carbon dioxide forced out of your lungs with the particles of lime in the water.

Blowing expired air through limewater

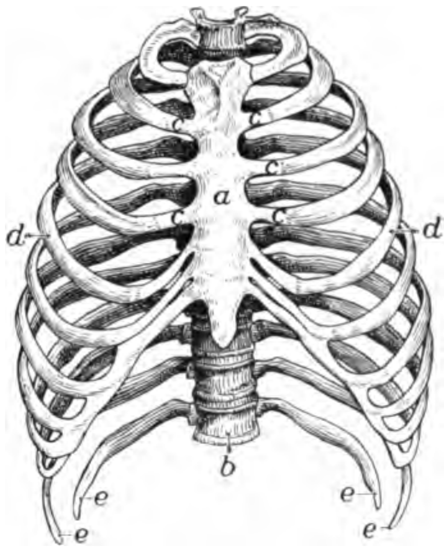
What is the practical meaning of these facts? This experiment shows you in a convincing way that if you breathe the same air over and over again you are continually loading it up with carbon dioxide and water. The water is not so very bad, because only a certain amount of it can be held in the air. If there is more than this amount, the excess will be deposited. The

carbon dioxide, however, is not deposited. It remains in the air indefinitely, and in unlimited quantities, and its presence cannot be known except in the way described.

What precautions does nature take to protect the lungs? Nature takes many precautions to protect the lungs. As we have learned, the lungs are covered by a membrane known as the *pleura*. They are located in the thorax or chest, a cavity that is entirely closed in by walls of bone and muscle. There is no communication between the thorax and the external atmosphere, although the interior of the lungs is connected directly with the outside air through the windpipe. No air can get into the thorax unless it leaks in through the lungs or through a puncture in the side walls. The walls of the thorax, with the exception of the diaphragm, consist of hard, bony materials,—namely, the ribs, the backbone, and the *sternum* or breastbone. This cavity therefore cannot collapse, and is able to resist the pressure of the atmosphere, which is about fifteen pounds on every square inch.

The walls of the thorax, moreover, are supported also from the inside. The lungs, being porous and expansible or easily stretched, and being in communication with the external air through the *trachea* or windpipe and the bronchial tubes, are expanded by the air pressure

until they entirely fill the lung space. The lungs, therefore, do not hang loosely in an open space, but, in a state of health, are entirely expanded so that their enveloping lining, called the pleura, touches the internal walls of the thorax. Thus, by the pressure of the air within the lungs, the walls of the thorax are supported from the inside also, and are prevented from collapsing under the pressure of the air on the outside.



The thorax or chest

a, sternum or breastbone; *b*, part of spinal column; *cc*, costal cartilages; *d*, ribs; *ee*, floating ribs

What causes the diseases that attack the lungs? Generally, when germs attack a healthy lung they are overcome and destroyed by natural enemies which nature has put into the blood and thus into the lungs. These enemies of the germs are principally the white *corpuscles* of

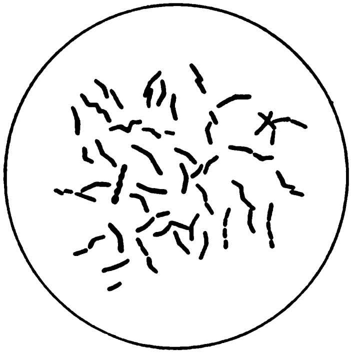
the blood. For a long time the function of these corpuscles was unknown. But it is now known that these little white particles in the blood, as distinguished from the red particles which give the blood its color, are police health officers. They are on duty to guard against all the thieves and robbers, the disease germs which strive to break into the body.

So long as we are well nourished and are living in sanitary surroundings these policemen are able to protect us against the bad germs which produce disease. On the other hand, when we are "run down," that is, when our vitality is lessened, when our food is poor or insufficient in quantity or not properly cooked, or when it is not properly chewed and digested, then we find that the white corpuscles are less numerous and are not so vigorous. These policemen, in other words, "go to sleep on their beats" and the thief and the robber germs enter the body and produce infection.

Thus we are apt to have pneumonia when we are weakened by a cold, although the particular germ which causes the pneumonia is independent of the cold. The pneumonia germ is almost always present in the mouth, but it does not produce pneumonia until the vitality (resistance) of the body is lowered.

Tuberculosis, that most dreaded of all

diseases, is produced by a certain germ called *tubercle bacillus*, which enters the lungs through the blood or through the air. It finds lodgment in the weak or less vital parts of the lung, grows and increases in numbers, and gradually produces the tubercles which absorb, destroy, and slowly take the place of the lung tissues used in breathing. Tuberculosis kills more people than any other single disease. Statistics show that out of every one hundred people who die, eleven die from this disease.



Tubercle bacilli

How can the diseases which attack the organs of breathing be prevented? Diseases can be prevented, first of all by always breathing pure air; second, by keeping the body well nourished; third, by taking precaution to prevent the spread of tuberculosis germs. When there is a case of smallpox in a community the patient is taken to a special hospital and separated from the community until he gets well. But this is not always done when there is a case of tuberculosis. A patient suffering from tuberculosis walks the streets, rides in street cars and railroad trains,

sits at the table in public restaurants, and in general mingles freely with the public, all the while spreading germs which threaten his fellow-man.

The germs of tuberculosis are also present in the milk of tuberculous cows. Tuberculosis in cows differs somewhat from the tuberculosis that attacks human beings. Although the germ is different to a certain extent, yet it has been proved conclusively that the tuberculosis of the cow may be reproduced in human beings, and especially in children. The extermination of tuberculous cows would do much toward diminishing the possibility of spreading tuberculosis.

If we could induce the people who have tuberculosis to live by themselves until they are well, and if at the same time we could destroy all tuberculous cows in the country, we should be protected to a good degree against that disease. Instead of eleven out of every one hundred people dying from tuberculosis we might reduce the number greatly. Moreover, if we could look forward to days of perfect sanitation of the air and of our food, we might even look forward to the day when tuberculosis would be completely wiped out.

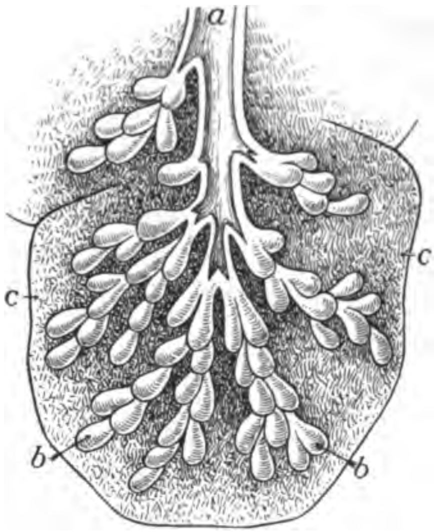
Your city and state boards of health would gladly undertake to eradicate tuberculosis and

other dreadful diseases if they were given the power and the money. Support the Board of Health.

The germ of pneumonia exists chiefly in the mouth. Therefore the mouth should be carefully cleaned at least three times a day, occasionally using a tooth paste that will help purify and clean the teeth. Rinsing the mouth with a sip of dilute hydrogen peroxide, or an antiseptic spray, such as a mixture of odorless petroleum, eucalyptus oil, and menthol, will also do much to keep this threatening germ out of the mouth. In addition to these everyday precautions special care should be taken when you have a cold to keep the mouth free from infection and also to prevent undue exposure to bad weather. At the same time particular care should be taken to keep the living-room temperature below seventy degrees and the air in the room perfectly fresh. With these precautions, a judicious diet, and plenty of sleep, you will be able to avoid an attack of pneumonia, a disease which kills almost as many people as tuberculosis.

What is the difference between the right lung and the left lung? The right lung is not shaped exactly like the left lung because of the position of the heart, which is placed more to the left than to the right side of the thoracic cavity.

The right lung is divided into three parts by deep clefts in the lung substances, although these parts are connected with each other so as to form one single organ. These divisions in the right lung are called the upper, the middle, and the lower lobe. The right lung is one or two inches shorter than the left lung because of the fact that the liver lies just below the diaphragm on the right side and pushes the diaphragm up against the lung.



A lobule of a lung
a, small bronchial tube; *bb*, air cells; *c*, lung tissue

The left lung is smaller and narrower than the right lung, but it is longer, and has only two divisions, the upper lobe and the lower lobe. It is a fortunate thing that the lungs are divided into lobes, or parts, by deep clefts. In pneumonia, for instance, usually only one of these lobes is attacked. If there were no lobes in

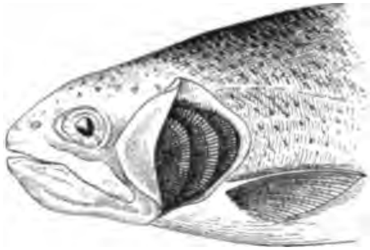
the lungs an attack of pneumonia might involve the whole lung. The physician is always hopeful of a recovery if he can confine the pneumonia to a single lobe.

How does a fish breathe? You have been told that any one who cuts off the air from his lungs by putting his head under water will drown. And yet, though fish have their heads under water most of the time, and though the same oxygen that purifies your blood purifies the blood of the finny tribe, still they do not drown. How then does the fish breathe?

The water in contact with the air absorbs some of the atmosphere, including all of the gases. Naturally the water near the surface is more nearly saturated with air than the water farther down. It is also clear that if the surface of the water is roughened by the wind, or splashed in any way, it comes in contact with greater quantities of air and absorbs more of it than if the surface were quiet. A fish breathes by extracting this absorbed air from the water near the surface.

Some of the animals that live in the water come to the surface to breathe above the water. The whale, for instance, which is not a fish, breathes in a great deal of air and blows it out again when it spouts. Some fish jump into the air and thus have a chance to breathe the air

above the water. In general, however, fish breathe by extracting the oxygen absorbed by the water which comes in contact with the open air.



Head of trout, showing gills

The fish, by the movements of its gills, which are its lungs, causes a large quantity of water to pass through and over them. The air contained in the water is absorbed into the gills of the fish.

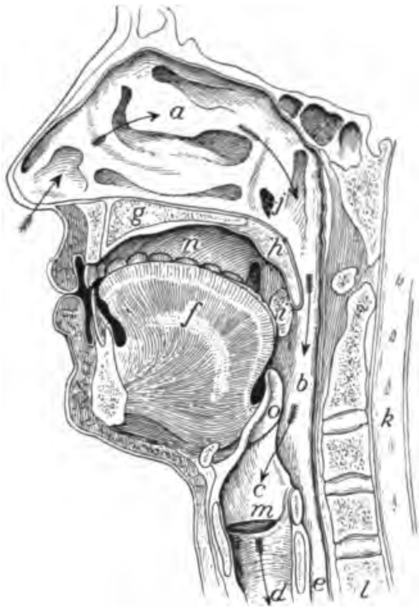
So, as long as the water contains air the fish is able to keep its head under water. But if the water is covered with a sheet of ice, and does not come in contact with the air, the air absorbed in the water will gradually be used up. Then the fish will suffocate. You may have seen in the spring a pond full of dead fish. They have been suffocated because ice entirely covered the water during the winter and kept them from coming in contact with the air. If there is a hole in the ice fish will seek it in great numbers, rising to the surface in order to get the oxygen that has entered the water. Thus we see that fish, if kept in water from which the air is excluded, would be suffocated just as human beings are suffocated by putting the head under water.

How does air enter the lungs? The air enters the lungs either through the mouth or through the nostrils. The nostrils are the natural breathing tubes or pipes and should be used for breathing at all times, except perhaps when one is talking or singing. Especially in sleep should the breathing be done through the nostrils.

The tube or canal in each side of the nose is not perfectly straight. The air in passing through the nostrils thus comes in contact with the moist membranes which line them. Particles of dust and other matter in the air are caught and held by the moist walls. They are thus prevented from entering the lungs. The membrane lining the inside walls of the nostrils is moistened by mucus and is called a mucous membrane. Thus the air that enters the lungs through the nostrils is freer from dust particles and is cleaner than that which enters through the mouth.

The cavity of the mouth. The mouth is one of the most important parts of the body in relation to health. In the mouth are the teeth, by means of which the food is masticated. It also contains the tongue, which carries the nerve of taste. Without our tongues we could make noises, but we could not pronounce words. The tongue also has important functions besides that of speech. By its aid the act of swallowing

is started. Then, too, the walls of the mouth contain the openings of the glands which secrete the saliva, so important in keeping the mouth moist and so useful in the chewing and swallowing of food.



Air passages of head and throat

a, nasal cavity; **b**, throat; **c**, larynx; **d**, trachea or windpipe; **e**, esophagus; **f**, tongue; **g**, hard palate; **h**, soft palate; **i**, tonsil; **j**, opening of eustachian tube; **k**, spinal cord; **l**, spine; **m**, vocal cords; **n**, roof of mouth; **o**, epiglottis; ⟶, passage of air through head to lungs

The lower part of the mouth is hinged near the ears and is movable. It can move up and down and sideways, thus aiding in the grinding of the food between the teeth, which act as upper and lower millstones. Back of the mouth are the *tonsils*, and farther on are the *trachea* or windpipe, through which the air is conveyed to the bronchial tubes and thence into the lungs, and the opening into the tube—the *esophagus* or gullet—through which our food is conveyed to the stomach.

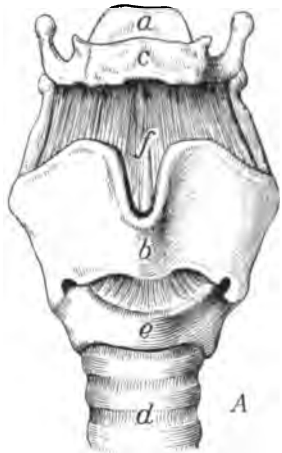
How does food enter the esophagus, and how does air enter the trachea? Why does n't the food which we swallow go into the lungs, and the air into the stomach? The answer to these questions is extremely simple. The opening of the upper part of the trachea or windpipe is called the *larynx*. This opening is covered by a movable hinged lid called the *epiglottis*. When we are about to swallow food the epiglottis closes so that the food slides over the top of the windpipe without entering. All of the food is thus conveyed to the esophagus.

The epiglottis
a, epiglottis; *b*, tongue; *c*, true vocal cords; *d*, false vocal cords; *e*, cricoid cartilage

If by any accident the epiglottis should remain open and a particle of food should enter the larynx, violent coughing would result. This is nature's effort to throw out the offending body. If water or other liquids that we are drinking should enter the larynx, similar spasmodic efforts would result to clear it of the invading substance.

The upper part of the trachea, as we have

already learned, is called the larynx. It is composed of a series of *cartilages* or flexible tissues midway between muscle and bone. Within it lie the vocal cords, two strong, fibrous bands covered by a thin layer of mucous membrane. They are of a light yellow color, very



A*, *Larynx, front view
a, epiglottis; *b*, thyroid cartilage; *c*, hyroid bone; *d*, trachea; *e*, cricoid cartilage; *f*, hyroid membrane

B*, *Larynx, posterior view
a, epiglottis; *b*, false vocal cords; *c*, true vocal cords; *d*, trachea; *e*, cricoid cartilage

elastic, and so arranged that they may be brought close together, or tightened or loosened, thus changing the tone of the sound produced. These changes are brought about by the numerous muscles in the larynx. If the trachea and bronchial tubes represent an inverted tree, then the larynx represents the root of the tree. It

is of great importance to keep the larynx in a healthful condition if the voice is to be preserved.

The air breathed out from the lungs causes the vocal cords to vibrate, thus producing sounds. If we had no vocal cords, or if they should become useless, we could not utter a sound, and the tongue, teeth, and lips would be deprived of sound material out of which to make words. If the vocal cords become inflamed, as in sore throat, they often become impaired or useless, and we are hoarse or speechless as long as the inflammation continues.

The cover of the larynx, that is, the epiglottis, protects the lungs and at the same time prevents any foreign matter from clogging the vocal cords. The vocal cords are stretched like the strings of a violin. They vibrate as the air passes over them, and a sound is produced when these vibrations are transmitted into the air. If the vocal cords are short and tight the voice is high and shrill, tenor or soprano; if the vocal cords are long and loose the voice is low and deep, bass or contralto.

What is choking? Choking is the term applied to the condition produced when the larynx is closed to such a degree as to prevent air from passing through the lungs. If you take your fingers and grasp your throat tightly you cause the trachea to collapse. This closes the passage

through which the air enters the lungs. If you hold the trachea shut long enough you cause death by strangulation.

If you should try to swallow a large quantity of food at once, so large that it would not pass through the esophagus, it would stick in the esophagus, bulging it out. As the esophagus lies back of the trachea, this bulging out might also close the trachea. In such a condition you would choke to death. If, on the other hand, the food were lodged in the esophagus in such a way as not to close the trachea, you might not choke to death for a long while, and if the obstruction were removed probably no harm would result. If food should enter the trachea through the epiglottis it would close the opening to the lungs and quickly cause death.

In case of choking of such a nature as to threaten speedy death, the person should be held head down and a series of sharp blows given with the palm of the hand on his back.

The palate. The roof of the mouth is called the *palate*. It is very hard and firm in the front part of the mouth. Toward the back of the mouth it becomes soft. In the middle of the soft palate at the back of the mouth hangs a small conical fold, which swings like a pendulum. This fold is known as the *uvula*. Sometimes the uvula becomes so long that it hangs

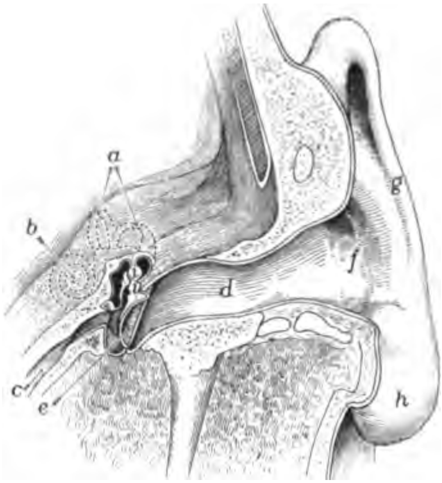
down and touches the top of the **larynx**, that part of the trachea holding the vocal cords. This produces a tickling sensation which induces coughing, and it is thus often troublesome to public speakers. In a case of this kind it is a simple operation to seize the projecting point with forceps and amputate or cut off the offending portion with a pair of scissors.

While I say this is a simple operation, I do not mean to say that it should be done by any but a competent surgeon, using sterilized apparatus so as to avoid every danger of infection or inflammation.

The tonsils. The *tonsils* are two glands situated at the back of the mouth. They are often the seat of infection and inflammation, especially in children. it is advisable in such cases, especially when the tonsils are enlarged, that they be removed by a surgeon.

The pharynx. Back of the mouth is the *pharynx*. It extends upward back of the soft palate and is bounded above by the lower wall of the framework inclosing the brain, and below by the beginning of the esophagus. In grown persons it is about four inches long. It is a kind of meeting place for various roads. The two principal roads opening into the pharynx are the mouth and the nasal passages. But there are other paths of very great importance

connected with the pharynx. These are the tubes which run from the pharynx to either ear, and are known as the *eustachian tubes*. They lead to the cavity in the ear located back of the membrane on which are recorded the sounds from the outer air. The lower contracted portion of the pharynx is the beginning of the esophagus.



Interior of ear with canals

a, semi-circular canals; *b*, cochlea; *c*, eustachian tube; *d*, meatus or auditory canal; *e*, drum membrane; *f*, concha; *g*, pinna; *h*, lobe; *i*, small bones of the ear

Precautions to be taken to prevent colds, catarrh, and like diseases. The most important thing to be considered is public sanitation, that is, the keeping of all public places in a sanitary condition. Especially is this true of street cars and schoolrooms. There are times when children should not be allowed to ride in street cars. Those hours of the day when the cars are crowded with passengers are the very times when children are most likely to be in the car on the

way to or from school. Even if he has to walk a mile or more, it is far better for the child to walk to school, and have the benefit of the pure air and the easy exercise, than it is for him to get into a crowded car in which there are not enough ventilating flues, and where the windows are often tightly closed and the doors opened only for the exit and entrance of passengers. The child will be better for the walk to and from school. He will do better in his studies at school, he will eat better, sleep better, and be healthier in every way because of this exercise. Above all, he will escape one of the very common conditions for taking cold.

All schoolrooms should be properly ventilated and the temperature in winter kept at sixty-eight degrees or less. When school authorities insist upon these conditions and when city children no longer ride to school, even though the street cars are sanitary and well ventilated, few of the pupils will suffer from colds.

Play and exercise of the right kind are valuable in preventing diseases of the respiratory or air-breathing organs. The play or exercise should not be too violent. It should, however, bring into activity all the different parts of the body. It is best for children to play in the open air, and all kinds of games are beneficial if the exertion is not greater than the body can bear.

Though outdoor play is to be preferred to indoor play, the gymnasium should not be neglected. If well ventilated, clean, and free from dust, it provides excellent opportunities for exercise when the weather is so bad that one cannot play out of doors. Outdoor play is for many reasons more beneficial than gymnastic

Children at play in the open air

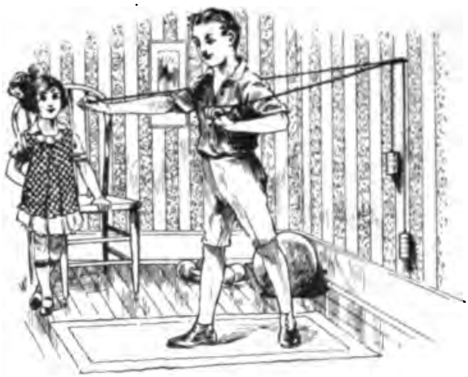
exercises. One reason is that gymnastic exercises are usually very severe on a particular set of muscles. The exercise is not so generally distributed over all the muscles as in outdoor play. It must be remembered, too, that even in the best ventilated rooms the air is not so pure as it is in the open. In addition to this, indoor play lacks the benefit to be derived from the sunlight.

Games should be a part of education. Learning to play properly is quite as important as learning other lessons. The most important thing of all is to learn the rules of health and make them practical by obeying them. In the freedom of outdoor play the lungs are filled with air naturally and without conscious effort. This is more beneficial exercise than if directed purposely to that end. Our mental state in outdoor play is also more favorable to beneficial results than it can possibly be in indoor play. There is an excitement and attractiveness in the outdoor exercise which can never be equaled by anything within four walls. On the whole, then, outdoor play is greatly to be preferred to indoor exercises.

How can play influence the organs within the thorax? All kinds of play increase the rapidity of the heart's action, and thus directly affect the organs inside the thorax. Since the blood runs directly from the lungs into the heart, from where it is to be sent back to the heart and then distributed throughout the body, there is a close relation between the action of the lungs and the action of the heart. As the blood circulation increases in activity the breathing becomes deeper and more frequent. The lungs are more expanded and respond at once to the stimulus of the increased circulation. Thus all

kinds of properly conducted play or exercises have a beneficial effect on the lungs and the heart.

In general, it may be said that exercises in which the arms and shoulders are used are especially helpful to the heart and lungs. The simple exercise of stretching both arms up over the



A helpful indoor exercise

head and holding them there for a short time may be practiced methodically. Bringing the arms down slowly, straight out from the shoulders and with fingers clinched so as to make the muscles tense, is also very helpful. The swinging of the hands backwards, at first slowly and gently and then more vigorously until the backs of the hands touch, is another helpful exercise. The circular movement of the arms around the shoulder as a pivot, throwing the head back and pressing out the throat and the top of the chest, is also a good exercise. Stooping over and touching the floor with the fingers without bending the knees, bending back

as far as possible, and bending the body to each side gently but firmly as far as you can, develops the muscles of the ribs and abdomen and increases the ability of the organs of breathing to do their duty. In all these exercises deep breathing and an occasional holding of the breath for a few moments to expand the lungs will be of benefit.

When exercises of this kind are taken indoors the full benefit is not received because of the confined air. The gymnasium, however, is the place for winter exercises when the weather is such that these exercises cannot be performed with comfort in the open. When the gymnasium is a well-ventilated room, free from dust, with plenty of sunlight through convenient windows, indoor exercises may be almost as beneficial as when taken in the open. Vigorous indoor exercise with dumb-bells is also helpful and greatly strengthens the muscles of the shoulders, the arms, and the thorax. The dumb-bells used should be light at first, but gradually the weight may be increased as the strength of the individual permits. Swinging by the hands, climbing a rope with the hands and legs, and other exercises of like kind increase the breathing capacity. All of these exercises should be taken under the direction of a competent director, so that they may be effectual and so directed

as to avoid harmful results. Playgrounds of the right kind for the development of a good physique, so necessary for efficiency in later life work, are equally as important as if not more so than good schools and useful employment.

What causes a cold? Most people think a cold is caused by a draft of air. If this were true everybody who goes outdoors, except on days of calm, would be in danger of taking cold. On the contrary, colds are nearly always produced by remaining in an overheated room in a stale atmosphere. If you have become very warm from vigorous exercise or work, and then sit down to rest where it is cool, your body may be cooled so rapidly as to close the pores of the skin and produce congestion of the internal organs. Then you have caught a cold. Mere changes of temperature, however sudden they may be, do not cause a cold unless certain cold-causing microbes start to growing in the body.

Can you catch a cold from another person? Yes, this is about the only way to get a cold. Somebody with a cold scatters the germs abroad and these, when breathed in, attack other persons, who then fall ill.

Why does not everybody who is exposed to such infection fall ill? If the body is well nourished, if it has been supplied with pure air and all the organs are in good condition, and you are

very healthy, you will be able to resist the cold-causing microbes. But if you are run down, poorly nourished, or very tired, your vitality is so low that it will not resist the microbes, and you become ill.

What makes a person who has a cold sneeze? Sneezing is a sudden contraction of the muscles which control the expiration of air from the

Sneezing is a source of danger to persons near by

lungs. By this contraction the air is ejected in a sudden puff through the nostrils or the mouth. The nerve causing this action is affected by an irritation in the nostrils or in the throat, and the sudden clearing of the air passages, by sneezing or coughing, is nature's way of getting rid of the irritation.

Is sneezing a source of danger to persons near by? Yes. In sneezing, the particles ejected from the

nostrils or the mouth may be thrown to a great distance, and these particles may be the carriers of infection. Never go near a person with a cold. Never kiss anybody who has a cold. If you can avoid it, never stand near a person who sneezes when he has a cold. To prevent others from becoming infected, a person should be considerate and always hold a handkerchief over his mouth and nostrils when he sneezes.

Should children with colds go to school? No. Children and grown people afflicted with colds should not go to school or into any public hall where lectures, plays, or religious services are carried on. Persons with colds should be kept at home, quarantined if necessary, until the danger from infection has passed. The air about a person who has a cold necessarily contains a great many germs thrown out by coughing and sneezing, and persons near by are in constant danger of breathing the infected matter into their lungs. The medical inspector or teacher should stand at the schoolroom door every morning and every noon and see that no person having a cold is allowed to enter the schoolroom.

Are there other places where the air may carry danger of infection from colds? Yes, many of them. Among the more common places of infection may be mentioned crowded street cars—especially in winter, when doors and

windows are closed—churches, theaters, moving-picture shows, and public meeting places of all kinds where large crowds are gathered in a small space. Children and even grown people often contract dangerous diseases in these crowded places from breathing air which carries the germs of colds or other diseases.

Are colds dangerous? No, colds in themselves are not as a rule dangerous. But a person afflicted with a cold easily contracts a more serious disease; indeed, he is much more likely to do so than when in good health. Such diseases as the grip, diphtheria, scarlet fever, measles, whooping cough, smallpox, and especially pneumonia, one of the most dreaded of all diseases, may follow a severe cold.

Spraying the throat for a cold

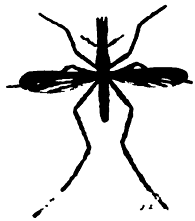
What is good for a cold? Rest, pure air, good food, some soothing or antiseptic material vaporized from a spraying apparatus into the nostrils and the throat, and proper attention to the bowels are helpful in overcoming a cold.

IV. How Mosquitoes and Flies Endanger Health

Are mosquitoes a menace to health? The results from the bites of some kinds of mosquitoes may be very serious. The *culex* or ordinary mosquito, except that it raises a lump with an itching sensation and withdraws a drop of blood, does no special harm. If you were bitten by enough mosquitoes you might bleed to death, yet the ordinary mosquito would not leave with you the germs of any disease. But in many parts of the country there is one species of mosquito that is especially dangerous. You have all heard of chills and fever. The common name of this disease is malaria. It was so called because of the mistaken supposition that chills and fever is caused by bad air. That is what the term "malaria" means. But we know now that it is not bad air nor night air that causes malaria. This disease is caused solely by the bite or sting of a mosquito, not the common kind, but a kind which is widely distributed.

The mosquito that conveys what is called malaria is the *anopheles*. When biting or stinging the anopheles mosquito assumes a position quite different from that of the culex. To stick her bill into the back of your hand the

culex stands up in a decent way and bends her head down. The anopheles, on the contrary, seems to stand on her head so as to give more punch to her entering bill. Then there is the *stegomyia*, another kind of mosquito which does not bother us except occasionally in the extreme southern part of our country. This variety of mosquito carries that dreaded disease, yellow fever.



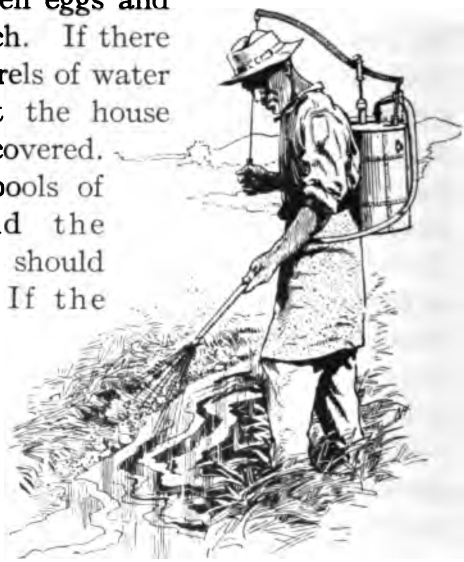
The mosquito which causes yellow fever

Neither the anopheles nor the stegomyia of itself is dangerous, but if an anopheles stings a person who has malaria the germs or parasites of malaria are developed in this mosquito and are then transmitted to the next person she stings. The same is true of the stegomyia. If she stings a person who has the yellow fever and then stings another person who has not the fever she conveys the yellow fever parasite to that person. In this way both malaria and yellow fever are spread.

What is the proper method of protection against these diseases? If possible, kill the mosquito. If this cannot be done screen yourself from mosquitoes. In a country where mosquitoes abound, no person should sleep in a place where windows or sleeping rooms are not carefully screened. In the daytime you can

usually protect yourself from the mosquito, but at night-time you fall an easy victim to her. It does not cost much to put mosquito netting around any place where you are sleeping. The one who does not take this precaution is very likely to be stung and suffer from the consequences.

What is the best way to get rid of mosquitoes? It is useless to try to kill all the mosquitoes. But it is easy to prevent their breeding. There should be no pools of water left where mosquitoes can lay their eggs and have them hatch. If there are tubs or barrels of water standing about the house they should be covered. If there are pools of water around the grounds these should be drained. If the swamps are too big to drain, the mosquitoes may be prevented from laying and hatching eggs



Spraying a pool of standing water with petroleum

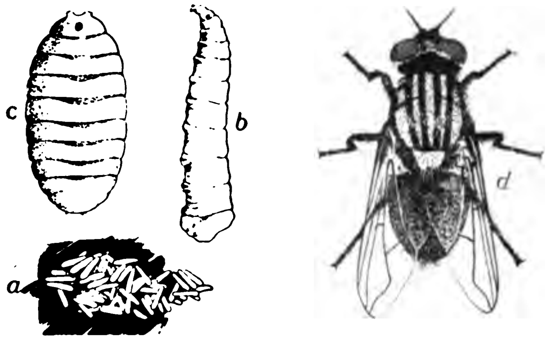
by pouring a little petroleum or coal oil on the water. The coal oil spreads in a thin film over

the surface of the water and prevents the development of the mosquito eggs. Large areas, as in Cuba and the Panama Canal Zone, have been freed from mosquitoes by taking this precaution.

What is good for the bite or sting of a mosquito? From his personal experience, Doctor Howard, Chief of the Bureau of Entomology, says the most effective remedy is moist soap. Take the end of a piece of ordinary toilet soap and rub it gently over the puncture and the irritation will soon pass away. Others enthusiastically recommend household ammonia, alcohol, or glycerine. The Rev. R. W. Anderson, of Wando, S.C., says he has found that holding his hand near a hot lamp chimney instantly relieves the irritation caused by mosquito punctures.

What is the relation of flies to ill health? Flies bear a very important relation to health. The fly is really the creature of filth. The eggs of the fly are laid in manure or filth of some kind, where they are hatched into maggots that remain in the manure until they pass into their *pupa* or inclosed stage, from which they presently come out as flies. Flies constantly visit every spot where manure or other filthy material is to be found. They go from the kitchen and dining room, where they are polluting the food,

to the stables and outhouses to lay their eggs, and then back again, bringing impurities to the food supplies. It is believed that typhoid fever, diphtheria, and other infectious disease germs are very commonly carried by flies.



The life of a house fly
a, eggs; *b*, maggot; *c*, pupa; *d*, full-grown fly

What is the best way to prevent flies? Cleanliness about the house, the outhouses, and the barns is the first requisite for success in the fight against flies. So, first of all, it is important to remove the filth in which the fly lays its eggs. It is estimated that one fly will lay one hundred twenty eggs. In from one to ten hours these eggs hatch into little white maggots. And within four or five days a maggot gradually turns into a fly. Then in about four days the fly is full grown and ready to start out on its errand of producing more flies. Thus one fly

will, in the course of a week or ten days, produce one hundred twenty flies. Thus you see in a very little time one fly can boast of a million descendants.

As flies cannot be entirely prevented from breeding, the next best thing is to keep them out of the house—out of sleeping rooms, kitchen, and dining room. This is most easily done by screens. The doors that lead out of the house should have double screens, so as to prevent the flies getting in when the doors are opened. Any fly found in a room should be killed immediately. The fly swatter is the advance agent of good health. "If at first you don't succeed, swat, swat again!"

V. Dust in the Air

What is it we see when a ray of sunlight enters a room, making a straight, shining streak? We see fine particles of dust which are invisible until lighted up by the ray of sunlight.

Is there usually much dust in the air indoors? Yes, there is, and also dust in the air in most other places. The dust indoors, however, is more injurious than the dust in the air outdoors. One should live as much as possible in the open air.

Stirring up dust with a broom

Does sweeping make more dust? No, sweeping does n't make dust; it only stirs up the dust that has gathered on the floor and sends it flying in the air again.

What is dust? Dust consists of particles or tiny bits of various substances, the particles being so fine and so light that when once started in motion they float in the air for a long time.

If you stir up some clay in water all the large

particles will soon settle at the bottom, but the clay dust remains suspended in the water for many hours and even for days. In the waters of the Missouri River the clay dust never settles. They are always muddy. In like manner dust particles float a long time in the air.

Can you get the dust particles out of water? Yes. If you mix a little lime water or a weak solution of alum with muddy water it will become clear in a short time. Substances like these cause the fine particles of clay suspended in the water to come together and form larger particles, which sink. Just so dust particles cling together and then sink in the air.

What results from the entrance of dust particles into the lungs? The dust particles often stick to the moist surface of the lung cells, causing irritation and injury. People who continually breathe air containing large numbers of carbon particles such as are present in the smoke from burning soft coal, often have black deposits of carbon in their lung tissues. Although it is not possible to find an atmosphere entirely free from dust, it is important to avoid, as much as possible, breathing dust-laden air.

How does dust get into the air? Dust is sent into the air by moving bodies in contact with the surface of the earth, especially when the ground is dry. A horse, wagon, or motor car

in motion will cause dust to rise from the ground. The wind probably is more effective

A cloud of dust caused by a motor car

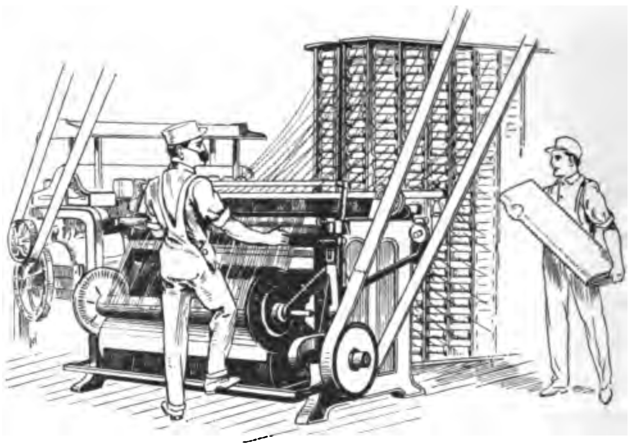
in keeping the air full of dust than any other moving body. It lifts the dust from the earth's surface, and the harder it blows the more difficult it is for the particles of dust to fall to the ground again. In many parts of the world, especially in deserts and arid regions, dust and sand storms are much feared. Sand storms and snow blizzards are much alike. In each case fine particles are carried through the air at a high rate of speed, blinding the traveler, so that often he loses his way. Sand storms are common in the deserts, and snow blizzards in the northern, central, and western parts of the United States.

How may those who must breathe a very dusty atmosphere protect their lungs? People who work in a dusty atmosphere may protect their lungs by placing a moist sponge over the nose and mouth. In passing through the sponge the dust-laden air strikes the moist walls of the sponge cells or spaces and the dust particles settle and remain there. From time to time the sponge is washed and then it is again ready for use. Threshing grain is dusty work, and farmers using threshing machines find wearing a moist sponge a great protection. Workers in cotton mills also find the sponge a protection

A sand storm in the desert

against the lint and dust that fill the air in factories and mills.

What care should be taken to diminish the amount of dust in houses? Houses should be built with smooth walls. Elaborately carved or irregular walls and ceilings provide places where dust may gather, and from which it is easily dislodged and set in motion by opening doors and windows and by "dusting." There should be no projections, moldings, or recesses where dust may gather. Such things as mantels, picture frames, and clocks should be frequently cleaned with damp cloths. The moisture in the cloth takes up the dust that has collected without causing it to start sailing through the air in the room. Floors should be smooth and without cracks. There should be no carpets, and rugs should be cleaned frequently. The best broom is a



A weaver wearing a sponge to protect his lungs from dust

vacuum cleaner. This appliance takes up all the dust. Even carpets are harmless if fre-

Cleaning a rug with a vacuum cleaner

quently cleaned with a vacuum cleaner.

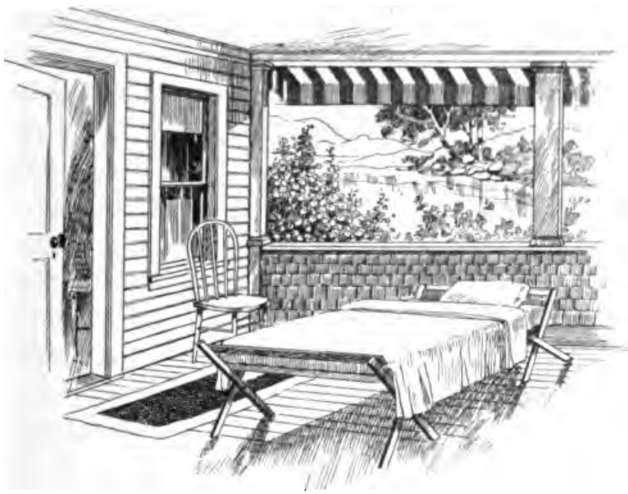
What is the danger from dust in the house? Disease germs are likely to be present in the dust, if there have been sick people in the house. The germs of tuberculosis, in particular, are likely to be present in house dust for some time if persons afflicted with this disease live in or visit the house. The sputum or spit containing the germs dries rapidly, and the germs float in the air like small dust particles. When lodged in the cells of the lungs these dry germs, if of recent origin, may become active again and thus start the disease that causes more than one tenth of all deaths. Tuberculosis is

sometimes called a "house disease." For if everybody lived out of doors there would be very little tuberculosis.

Are the germs of tuberculosis spread about in any other way than through the air? Yes, tuberculosis germs are spread about in many different ways. The infection may come from direct contact, as in drinking from a cup that has been used by some one suffering from the disease. It may also be caused by eating food from dishes which have just been used by consumptives, or by drinking the milk of tuberculous cows. A person may also get tuberculosis from eating the unsterilized meats of tuberculous or infected animals, especially cattle and hogs. These are but a few of the things which cause infection.

How can we be protected from these dangers? We can best protect ourselves by spending as much time as possible in the open air. While disease germs may be present in the air currents out of doors, because consumptives have been spitting in the street or for other reasons, the danger of inhaling these germs is comparatively slight because of the great quantity of air in which they are carried. On the other hand, the air indoors is breathed over and over again, and even if there were but a few dangerous germs in the room, the chance of breathing

them in is very great. Sleeping on porches and spending as much time as possible outdoors during the day are good ways for preventing this disease. Children especially should sleep in the open, for it is often in infancy and childhood that this disease takes hold. The germs that develop into tuberculosis at twenty-five or thirty years of age often enter the lungs during childhood, and their presence is not



A sleeping porch. People who sleep in the open air usually are free from disease

discovered for many years. Persons who live and sleep indoors, in rooms that are poorly ventilated, offer the most favorable conditions for the development of the disease.

Is there any danger in sleeping out of doors?

As a rule, there is none whatever. In pleasant weather one may sleep on the ground with an oilcloth blanket under him and a blanket over him. If it rains he should, of course, have some kind of protection, such as an oilcloth covering, to keep him dry. People who live out of doors, play out of doors, and sleep out of doors rarely have colds or tuberculosis or diseases of the throat.

VI. A Study of Ventilation

What is ventilation? "Ventilation" is the term applied to the circulation of fresh air through rooms in which people live, sleep, and congregate. In a well-ventilated room the air is so frequently or continuously changed as to prevent it from becoming stale or contaminated.

Why is ventilation necessary? Air at rest becomes stagnant in the same way that water at rest becomes stagnant. So it is desirable to keep it in constant motion. This may be done either by mechanical means—as, for instance, by an electric fan—or else by taking advantage of the tendency of heated air to rise and thus cause movements of the whole air mass. Air confined in a room is usually of a different temperature from that of the air out of doors. It may be warmer or colder. As a rule, air indoors tends to be warmer. Thus, if a flue opens into the room, the tendency of the confined air is to pass up that flue. Then air of a different character will enter through various openings, such as the cracks under the doors and around the windows, or other ventilating spaces, and take the place of the air that has passed up the flue. If there is a chimney and fireplace in the room the chimney itself becomes a ventilating

shaft through which the warm air escapes. Entering a room in a building which has been kept tightly closed, you at once notice the difference between the stagnant air of that room and the air in rooms where the doors and windows are open at all times and the air is kept in constant motion. Thus we see the first principle of ventilation is to prevent the air from becoming stagnant.

Ventilating a room with a screen at bottom of window

How does the air become contaminated? In a room tightly closed, which has in it no source of contamination, air would not change in character even if it became stagnant. But in living rooms, or in rooms where people sleep or congregate, the air is being constantly used in breathing. We have

learned that the air which is expelled from the lungs is of a different character from that which is taken into the lungs. Now if we regard the air that enters the lungs as pure, then the air that is expelled from the lungs is impure. This impure air breathed from the lungs mixes with the pure air in the room and gradually the whole mass of air about us becomes impure. The smaller the room space or the greater the number of people gathered therein, the more rapidly will the air become contaminated.

If gas jets or oil lamps are burned in a room an almost similar change takes place in the air. The flame of the lamp or the gas is fed by the air. The air that is used by the flame may be regarded as pure, but the air that comes away from the flame is impure. Moreover, if there are living beings in the room they are constantly throwing off impurities into the air.

Thus the air in a confined space where living bodies are present, or where oil lamps or gas jets are burning, and where there is no provision for a rapid change of the air, becomes continually more and more impure. Also, if cooking is done in a room, impurities rising from the foods being cooked tend to add to the contamination of the air. In order to secure the best conditions of health, the air in living rooms must be frequently and systematically changed.

What are the best methods of changing the air in a room? The influence of fireplaces and chimney flues and of cracks under doors and about windows has already been explained. Though not intended for that purpose, all these openings promote ventilation. In some dwellings and public assembly halls, however, apparatus is especially installed for ventilating purposes. Ventilating flues are placed in the walls when the buildings are constructed. The size of the opening into the rooms may usually be adjusted by mechanical means, according to the needs of the space to be purified. These openings are generally called "registers." They may admit warm air or cold air, or they may lead off the impure air.

Forcing impure air out with registers

Ventilation is best regulated when mechanical ventilating appliances are used. Ventilating by mechanical means generally follows two methods: One method is to force fresh air through pipes into a room by machinery

installed for that purpose, thus forcing the same volume of air out of the room. The other method is to connect the ventilating flues with a suction fan so as to draw or suck the foul air away. The ventilating machinery may be so arranged as to regulate the temperature also, by heating or cooling the air that is forced into the room.

Where no mechanical ventilators are installed the doors and windows may serve. If the window is opened from the bottom, a plate of glass or a board should be used as a screen, so as to direct the air upward into the room and not allow it to flow straight in at the bottom. If two windows are used for ventilating purposes one should be opened at the bottom and the other at the top. Wire screens covered with cheesecloth are excellent with open windows.

VII. A Study of Temperature

What is the most desirable temperature in a room? The temperature in a room in which work of any kind is carried on should not exceed sixty-eight degrees. Experience has shown that this is the most favorable temperature for the best results and the highest efficiency of the worker.

When the temperature out of doors is below sixty-eight degrees the temperature indoors is kept up by means of fireplaces, stoves, furnaces, hot-water pipes, steam pipes, or by electric heating. All of these methods are good if properly regulated.

When the atmosphere outside is warmer than sixty-eight degrees there is no method in general use for reducing the temperature. The temperature may be reduced indirectly, however, by means of awnings which shield the room from the heat of the sun and thus tend to keep it comparatively cool. In some public halls artificial refrigeration is practiced. Air that has been cooled by passing over ice or over pipes filled with cold brine is forced into the room by means of ventilating appliances. This adds much to the comfort of the people in the hall, but the process is expensive and so it is

not often used. Only wealthy people can afford a machine of this kind in their homes. In other words, it costs more to cool the air in summer, with the appliances that are now available, than it does to warm it in winter.

However, so far as comfort is concerned, it is much more important to heat cold air than it is to cool hot air. If the temperature does not go above eighty-five or ninety degrees, worrying over hot weather causes far more discomfort than the hot weather. A natural temperature of from seventy to eighty or even eighty-five degrees causes no great discomfort to most persons. On the other hand, should the temperature of a living room fall to fifty or forty-five degrees, unless the people in the room are wearing very heavy outdoor clothing or are tucked in bed under warm blankets and quilts, they are extremely uncomfortable.

The evils of overheating. One of the common evils in the United States in cold weather is overheating. This custom prevails everywhere —in private houses, in schoolrooms, in churches, in public offices and theaters, in railway cars and street cars, and in fact everywhere that people gather. It is not unusual to find the temperature of a living room during the winter much above seventy degrees, and even as high as seventy-five and eighty degrees. This is

sometimes called a "house disease." For if everybody lived out of doors there would be very little tuberculosis.

Are the germs of tuberculosis spread about in any other way than through the air? Yes, tuberculosis germs are spread about in many different ways. The infection may come from direct contact, as in drinking from a cup that has been used by some one suffering from the disease. It may also be caused by eating food from dishes which have just been used by consumptives, or by drinking the milk of tuberculous cows. A person may also get tuberculosis from eating the unsterilized meats of tuberculous or infected animals, especially cattle and hogs. These are but a few of the things which cause infection.

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or eighty degrees. If there is no established regulation, the one who wants the most heat usually gets it.

In public buildings, schools, theaters, public halls, churches, street cars, railway cars, and similar places, the temperature should be regulated according to a fixed rule. The general public, moreover, should be taught to avoid the dangers of overheated rooms in the home. The living room should never be heated to a temperature of eighty degrees. But many mothers have never been taught that.

When the air out of doors is warmer than sixty-eight degrees, as it is sometimes early in spring and nearly always all through summer and a part of autumn, the windows should be opened wide, and also the doors, if that will help to let the breezes blow through the room. When the air is changed continually in that way it is surprising how easily we can bear a temperature above sixty-eight degrees. Anyway, a temperature that is high because of natural conditions, as it is in summer, does not threaten health. The air is pure, it is constantly changed, and it is not contaminated by the breath of people.

What are the chief obstacles which prevent perfect ventilation? The first obstacle is ignorance of the principles on which ventilation is based;

second, the difficulties and the expense of changing the air in living rooms during the winter when the cold is intense. It is evident, therefore, that many of the evils resulting from poor ventilation, especially when they are due to cold weather, will continue for a long time without effective remedy. In short, one of the principal difficulties is the cold of winter. When it is cold many people think they cannot afford to open the windows in their living rooms, and very frequently fail to do so in their bedrooms, much to their own discomfort and injury.

What should be the temperature in a bedroom? The temperature in a sleeping room should be much lower than that in a living room. In fact, the temperature in a sleeping room, except at high altitudes in the north, should be the same as that out of doors. The windows and even the doors should be left wide open. Sleeping rooms, moreover, should never be heated by artificial means except in cases of extreme cold in high northern latitudes. Instead, there should be enough bed covering to keep the sleeper warm.

The bed should not be in the living room. Unfortunately, very poor people cannot always have both a living room and a bedroom. But wherever it is possible the bedroom should be

separate from the living room, and it should not be heated above sixty degrees by artificial means. If artificial heat cannot be entirely cut off, then the windows and the doors should be opened so much the wider. The outdoor sleeping room or the sleeping porch is the ideal place to sleep, though it is not possible for everybody to have one.

When the children now growing up have learned the fundamental principles of ventilation, and know what the proper temperature of the air should be, a great change will take place in the homes of our people. In the near future even the humblest homes will be provided with means of ventilation as well as the other conveniences a home should have.

Why is air in motion more agreeable than air that is not in motion? Every one has noticed that when the air is motionless the high temperature of a summer day seems harder to bear than if a breeze is blowing, no matter how lightly. But the air in motion is not really cooler. It is the constant change in the particles of air that come in contact with the body that makes a person feel refreshed. In all living rooms and sleeping rooms it is important to keep the air in gentle motion, either by the natural process of ventilation or, in very warm weather, by means of an electric fan.

shaft through which the warm air escapes.

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Ventilating a room with a screen at bottom of window

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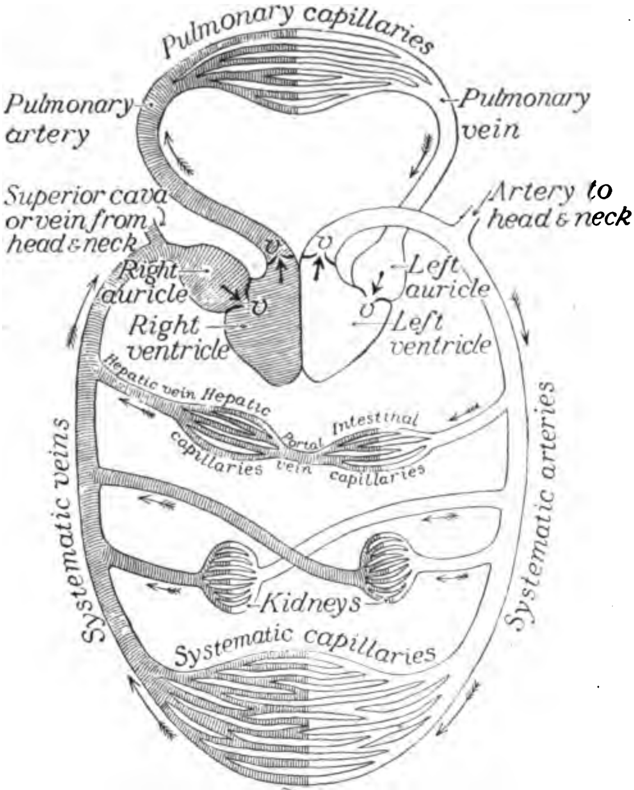
the hair, a fourth to form the skin, and so on through all the tissues of the body. All of these



The circulation of the blood

v, valves to and from the heart; arrows indicate direction of circulation

food materials are taken from the blood stream. The blood also carries particles of oxygen to the various tissues which, their usefulness at an end, are now ready to be destroyed.

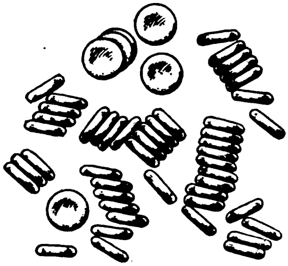
Quite as important as carrying the oxygen and the food is the work of the blood in carrying off waste material. It takes the waste material away from the tissues, and carries it to the various organs in the body, whose function is to separate it and eliminate it from the body. These organs are chiefly the skin, the lungs, and the kidneys.

As we already have learned, an important function of the blood is to bring the carbon dioxide, which is produced by burning food and tissues, and water back to the lungs. There a large part of the water and some of the carbon dioxide leave the blood by passing into the air through the thin membranes of the small cells in the lungs. At the same time an equal amount of oxygen passes in the opposite direction and enters the blood. Thus the blood not only carries oxygen to the tissues but carries water and carbon dioxide away from the tissues.

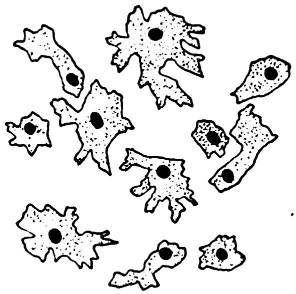
What is true of the human being is also true of all animals that have blood. They all have the same system of circulation, and for the same purpose, with only such variations as the different conditions in which they live have brought about. The blood may properly be called the life of the body. Without its circulation through the body, life would be impossible. Anything that impedes or prevents the

circulation of the blood causes speedy death.

The red particles of the blood are minute cells, called corpuscles, which have the ability to absorb oxygen. They play very important rôles in nourishing and vitalizing the body. The red particles may thus be regarded as the most important constituent of the blood.



Red corpuscles



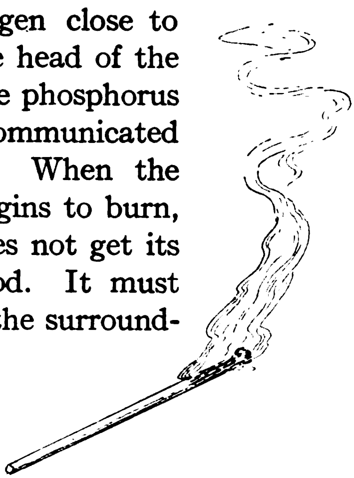
White corpuscles

Are there any other particles in the blood? Yes, there is a very important family of particles in the blood, known as the white corpuscles. These are somewhat larger than the red corpuscles, and much less regular in shape. For a long time their particular function was unknown. You have already learned that these white particles are of extreme importance. For they are what may be called the policemen, or sentinels, of the body. They attack any invading germ which might cause illness, and drive it away or take its life. For this reason the white corpuscles are called *phagocytes* or "cell eaters."

If the body is well nourished the white cells are vigorous and numerous and are able to destroy any harmful organism that may enter the blood. If the body is starved or otherwise weakened the white corpuscles are less numerous and less active. The disease-bearing organisms then escape destruction, fasten themselves on the organs of the body, and produce the various contagious and epidemic diseases from which we suffer. Tuberculosis, diphtheria, measles, small-pox, typhoid fever, and pneumonia are types of such diseases. Hence the importance of having the blood sound, healthy, and vigorous.

IX. A Study of Combustion

What are the relations of air and fire? There can be no fire, as it is commonly understood, without air. When we strike a match for the purpose of lighting a fire, the friction causes enough heat to ignite the phosphorus on the match, an easily inflammable substance. The large quantity of oxygen close to the phosphorus on the head of the match is liberated, the phosphorus burns, and the fire is communicated to the wooden stem. When the wood of the match begins to burn, however, the flame does not get its oxygen from the wood. It must draw its oxygen from the surrounding air. Thus, after the flame is started by friction it continues to burn by taking oxygen from the air. As the little particles of oxygen in the air rush into the flame and unite with the wood, sufficient heat is generated to start a more rapid combustion, and this burning will continue until the flame is extinguished or until all the



A lighted match

combustible matter in the wood has been burned up and only a little carbon remains.

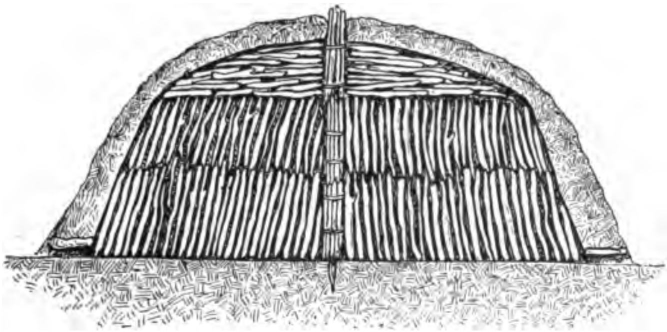
How does coal burn? Coal burns in exactly the same way as wood. But as a rule more heat is required to ignite coal than to ignite wood. The coal fire, therefore, must have more kindling before it ignites, though the principle is exactly the same in both cases. The little

A charcoal furnace

particles of oxygen in the air unite with the coal at a high temperature. This produces additional heat, and thus the combustion is transmitted from particle to particle until all has been consumed. Burning is a chemical process.

What is the element in wood and coal that helps to make the flame and the heat? When wood and coal are burned, oxygen unites with a substance

called carbon. You are familiar with carbon in many of its forms. When your lamp smokes it turns the chimney black with a coating of carbon. Carbon is present in large quantities in coal. It is also present in charcoal, a material produced by burning wood and limiting the amount of oxygen so that the wood will not be entirely consumed. A diamond is pure crystallized carbon. So-called "lead" pencils



Section of a charcoal furnace, showing arrangement of wood for burning

are made of graphite or "writing stone," which is another form of carbon.

What substances are produced when wood and coal are burned? The burning of wood, coal, gas, and oil produces practically the same substances as are produced by the burning of foods and tissues in the body. The gases that are formed consist principally of carbon dioxide and water. The oxygen in the air unites with

the carbon and hydrogen in these various materials—wood, coal, food, and bodily tissues — and carbon dioxide and water are the results of the combustion.

Thus the principal products of combustion, whether in a fireplace, in a stove, in a furnace, in a lamp, in an engine, in an automobile, or in a human body, are carbon dioxide and water. The water is gaseous at the time of its production, because of the high temperature, but when it passes into the air it readily cools and, if the air is nearly saturated with it, fogs and drops of water will form. The carbon dioxide passes into the air just as it does from the lungs, and immediately mixes with the air. The amount of this gas present in open air is not great. The proportion of carbon dioxide in the air is about four parts in ten thousand, and remains almost the same, except in the neighborhood of large cities and factories.

X. The Temperature of the Body

What is the relation of the heat of the body to health? The temperature of the human body when in a state of health is practically unchanging. It is about ninety-eight and a half degrees. The heat of the body is maintained by the union of the oxygen of the air which enters the body through the lungs with combustible matters — the foods and tissues — in the blood and in the capillaries.

Our usual idea of combustion is a burning with a flame or a visible glow. Any process by means of which oxygen combines with organic matter and produces heat is combustion.

A heating stove

We usually think of fire in connection with a stove or a fireplace or a furnace. But the

flameless fires which warm the human body are in the blood and in the minute blood vessels or capillaries of the body.

Because the lungs are the organs which take up oxygen it must not be inferred that the combustion which heats the body takes place in the lungs. The lungs simply provide a

An open fireplace

means of starting the oxygen taken up from the air on its way to the various parts of the body where the burning takes place. The fires that burn in the body have no visible signs of flame or fuel.

How is the heat of the body kept constant and normal? The normal temperature of the body is about ninety-eight and a half degrees. This seems

to be the temperature at which the functions of human life are carried on to best advantage. If the temperature rises above that point we have a fever; if it falls below that point we are at the point of collapse. Thus nature must keep the body at a constant, even temperature, and this is accomplished by various means.

In most parts of the world and at almost all hours of the day the body is warmer than the air. Therefore heat is constantly passing from the body to the air. Thus radiation from the surface of the body disposes of part of the excess heat in the body.

Large quantities of heat are also carried out of the body in the air breathed out of the lungs. The air enters the lungs, say at a temperature of sixty-eight degrees. It leaves the lungs at a temperature of about ninety-eight and a half degrees. Thus a large quantity of heat leaves the body by way of the lungs.

The pores of the skin, also, are constantly exuding or discharging water known as perspiration or sweat. This water also carries off a large quantity of heat. As it comes to the surface of the body it evaporates, absorbing a great deal of heat and thus cooling the surface of the body. The drier the atmosphere, the more rapidly the water evaporates. In very dry climates temperatures of one hundred ten

or one hundred fifteen in the shade are endured without much discomfort because the rapid evaporation of the sweat keeps the surface of the body cool. When we work very hard, or the air is very warm or is saturated with the vapor of water, the sweat gathers in drops and often runs off the body like raindrops from the clouds.

Thus the lungs and the skin play almost equal parts in providing for the distribution and projection into surrounding space of the surplus heat caused by the regular activities of life.

And while nature burns a great deal more material than is necessary to keep the body warm enough, it has so arranged matters that the inner temperature remains practically the same all the time. The activity of all the organs thus remains normal, and health is maintained.

Other factors must also be considered in this connection. The building of houses, the wearing of clothing, and the custom of heating the air in which we live, all tend to maintain an even temperature in the body.

What rule should govern the wearing of clothing? For the purpose of keeping the body warm, clothing should be adapted to the season of the year. Heavier clothing should be worn in cold weather, and lighter clothing in warm weather. Clothing, however, should always be as light

as possible, though heavy enough to secure the desired result. Too much clothing is very

Boys wearing heavy and light-weight clothing

injurious, especially to children. Too much clothing impedes the work of grown people, reduces efficiency, and throws upon the excretory organs of the body a larger burden than they otherwise ought to bear in order to get rid of the excess of temperature.

In cold weather, if you are to be kept indoors most of the time, it is advisable not to wear too heavy underclothing. It is far better to have temporary wraps, overcoats, and cloaks to put on when you go out and to lay aside when you again go indoors. In most houses the temperature in winter is kept as high as and sometimes higher than in summer. Although the

temperature of the living room should be kept practically at sixty-eight degrees, it is a very common thing to have it much higher, especially in schoolrooms, public halls, and churches, as well as in offices. A great many people spend their winters in rooms heated to above seventy degrees and sometimes as high even as eighty degrees. At the same time they wear heavy winter clothing. Such practices cause serious injury to health.

It is advisable not to wear heavy underclothing, even in winter. If you go out of doors and are not engaged in active work, overcoats and cloaks and wraps will keep you warm. If you are engaged in active work out of doors, you will not need nearly so much clothing, and as it is usually necessary to go indoors from time to time, heavy clothing would be a burden. Thus it is a mistake to wear heavy underclothing in winter. The danger is especially great in the spring, when the heavy clothing is changed for lighter and the weather suddenly becomes cold again. In order to avoid this danger the safest plan is to wear as little clothing as you can to protect you from the cold.

In what other ways may we control the heat of the body? The character of the food we eat is highly important in this connection. This point will be treated fully in another part of the

book. It is sufficient now to say that the heating foods are especially the fats. A certain quantity of fat produces as much heat, when burned in the body, as two and a quarter times that quantity of sugar or starch, and more than twice as much heat as the same weight of a nitrogenous body, such as lean meat, the white of an egg, or casein of milk. In cold weather, therefore, we should eat more fat and in warm weather less fat. Meats and oils, the foods that contain fat, while splendid foods for winter, should be eaten only in small quantities in summer. The importance of thus controlling the temperature is not sufficiently appreciated by most persons.

What causes a fever? A disordered condition of the body causes a more rapid combustion of materials in the body than when in a normal state of health. The result is an amount of heat which cannot be controlled or expelled rapidly enough to prevent a rise of temperature, and we have what we call a fever.

The fact that we have a fever always indicates some disordered condition of the body which may or may not be of a serious character. A rise of temperature of even one degree is the signal that the body has passed from a state of health to a state of ill health. It is true that in a state of health the normal temperature may

vary almost as much as one degree during the day, there being daily variations, as well as variations at longer intervals. There is always a slight increase in temperature after violent exercise or after eating a hearty meal, or perhaps as the result of some undue excitement. Such increases, however, are not sufficient to cause disorder in the functions of the organs, and do no harm.

As a rule, nature's first signal that something is wrong is a variation in the heat of the body. On a railway train, when the oil is not properly transmitted to the axle, we have a hot box. The railway car, in other words, has a fever.

Just what the direct causes are for the increased combustion in the body is not well known. It is certain that the high temperature is not the cause of the disease, but it is certain that the disease is attended by the high temperature.

How high does the temperature rise in case of sickness? In a light fever the temperature of the body is from one to two degrees higher than normal. When the fever is severe the temperature reaches one hundred three or one hundred four degrees, or four and a half to five and a half degrees higher than normal. If the temperature rises above one hundred five degrees it is an indication that the patient is in

a very serious condition. In very severe cases of fever, as in typhoid, the temperature sometimes reaches one hundred five and even one hundred six degrees, and yet the patient will recover. Such high temperatures, however, are usually a sign of approaching death.

How may the temperature of the body be measured? The temperature of a sick person is measured by means of an instrument known as a clinical thermometer. The clinical thermometer is a small, carefully constructed thermometer, so adjusted as to register temperatures from ninety-five to one hundred ten degrees. Generally the bulb of the thermometer is placed under the tongue and the mouth tightly closed. The clinical thermometer is so delicately adjusted that within one or two minutes after it is placed in the mouth it will register accurately the maximum temperature of the mouth. The column of mercury is also so adjusted that it will remain at the highest point. Thus it may be read at leisure, and an accurate record secured.

Clinical thermometer

What are some of the principal evils of overheating? Overheating, if it is not excessive, does not as a rule produce any great increase of temperature in the body, for the reason

that the healthy body is able to eliminate the excessive heat. Overheating and too much clothing are common causes of ill health and suffering. Children and especially infants are injured, for the tendency of careful mothers is to bundle them up with entirely too much clothing. While it is true that an infant should be carefully

The way of the modern school girl

protected from the cold in the first days of its life, it is soon strong enough to bear a cool atmosphere without an excessive amount of wraps. A great many infants are injured and even killed by too much clothing.

The quantity of bed clothing should not be greater than is necessary to keep a person warm. If his digestive functions are in good condition

a healthy person can sleep comfortably in a very low temperature without having a large quantity of bed clothing. At certain times in northern climates the temperature falls very low. On such occasions, of course, more clothing for outdoor use and more bed clothing are necessary.

Mothers should never wrap warm clothing around the necks of their children. The person who wears fur collars, comforters, and such things around the neck catches cold very easily. Children's clothing especially should be so made as to leave the neck bare. In this way they are much more likely to go through the winter without colds. The health of the child should never be sacrificed to the prevailing styles, if these require such things as bandages, high collars, or other articles of that kind around the neck.

The keeping of an even temperature in the body is one of the fundamental conditions of health. If we desire to aid nature we must be careful in regard to our eating, in regard to the temperature of the rooms in which we live and of those in which we work, and in regard to the kind and amount of clothing we wear.

XI. The Skin and its Functions

What are the functions of the skin? The skin is the protective envelope covering the body. It exercises important functions. It plays an important part in the maintenance of an even temperature in the body. It serves to protect the more tender tissues under it, and to take care of certain excretions which are essential to health and life.

One of the chief functions of the skin is that it gives us the sense of touch. Innumerable nerves or nervelets connected with the larger nerves and the nerve centers of the body terminate in the skin. We feel through the skin. The nerves in the skin carry the sensation of touch to the nerve centers and to the brain. We can tell by touch whether things are hard or soft, hot or cold. Thus to a great extent it is through the skin that we become acquainted with the outside world. Blind people, through their sense of touch, read with their fingers.

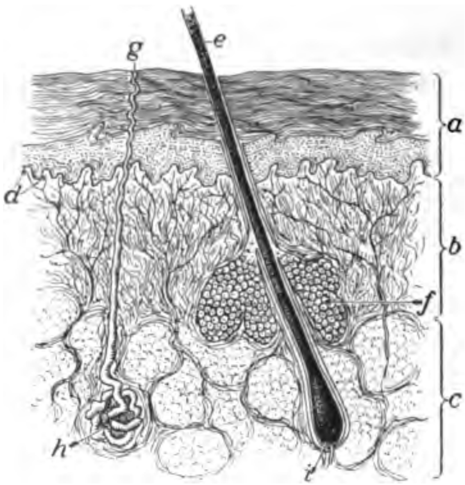
What is the structure of the skin? The outer layer of the skin is called the *cuticle* or *epidermis*. This outer layer of the skin is constantly being rubbed off, while materials for a new outer layer form under it. The cuticle carries neither nerve filaments nor blood vessels; hence it may

be removed without pain and without causing any blood to flow.

If the cuticle is rubbed continually, additional tissues are deposited and it becomes hard and thick. If you examine the hands of a man who does rough work, you will find the skin comparatively hard, tough, and thick. The cuticle on the sole of the foot is much thicker and harder than it is on the top of the foot. When boys go barefoot the cuticle on the soles of their feet thickens and hardens. If a person wears a shoe that rubs on the skin over a joint, or if the skin on other parts of the body is rubbed continually, the cuticle becomes hardened and the result is what is called a corn. This hardening of the skin is nature's effort to give added protection to the parts that are being rubbed.

Underneath the cuticle is the *dermis* or true skin. On the surface of the true skin are spread the little projections which hold the terminals of the *sensory* nerves or the nerves by which one feels. Here also are the sweat glands, the roots of the hair, and the oil or fat glands. In addition to the protection which the skin provides as a covering for the body, other means of protection are provided by nature—for instance, the hair and the finger nails and the toe nails. The nails and the hair are really skin tissues with special modifications according

to the needs of the body. There is no better protection for the head from the heat of the sun and the cold of the winter than a thick covering of hair.



The structure of the skin

a, epidermis; b, dermis; c, fatty tissue; d, papillae; e, hair; f, oil glands; g, duct of sweat gland; h, sweat gland; i, papilla of hair

The skin of the whole body is covered with hairs. They are usually very small, but they can easily be seen either with the naked eye or by means of a magnifying glass. Each hair grows up through the skin much as a seed grows up through the soil. The hair does not conduct heat or cold, and therefore a covering of hair or fur is one of the best protections against changes of temperature. Animals that live in cold climates have heavy fur. This fur is a protection both against the heat of the sun in summer and the cold of winter.

How does the skin perform the function of regulating temperature? We have already learned

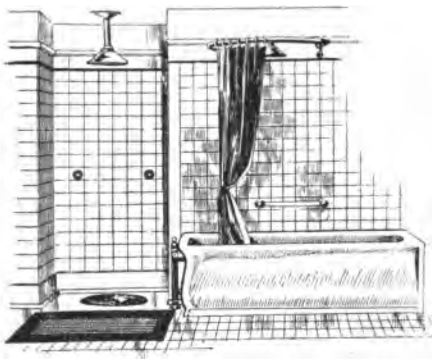
that the heat of the body is influenced not only by the thick covering the skin provides but also by the sweat glands in the skin. The sweat glands eject certain watery secretions from the body. But sweat is not pure water. Sweat contains other substances in solution, among them considerable quantities of common salt. Sweat glands are present in all parts of the true skin, though not in the cuticle. They are usually surrounded by particles of fat. This fat keeps the sweat glands pliable and assists them in their important work. Each one of these glands has a very small duct or tube which leads spirally, that is in a winding way, through the true skin and the cuticle. The opening is not even with the surface of the skin, but is oblique, so as to be more easily protected from becoming clogged by substances clinging to the surface of the cuticle. These ducts are larger and more numerous in the skin in those parts of the body that are most active in sweating, as, for instance, in the skin of the forehead and the arm pits. It is estimated that on the palm of the hand there are about three thousand of these openings to each square inch of surface.

We have already learned that one of the two principal products of combustion in the body is water, the other being carbon dioxide. Much

of this water is excreted or thrown off through the sweat glands, while the carbon dioxide is almost entirely excreted through the lungs.

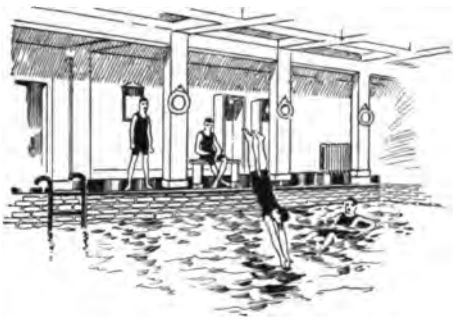
Is cleanliness of importance to health? The skin may be regarded as a machine. As in the case of other machines, its efficiency may be maintained only by close attention and care. If a watch is to be kept running accurately it must be taken apart from time to time and thoroughly cleaned. The watch, in other words, must have a bath.

The surface of the skin is constantly exposed to contamination from its own excretions, and from those substances which may be deposited on it from the atmosphere and from the objects with which it comes in contact. Hence frequent cleansing of the skin is necessary. Careful boys and girls will wash their hands several times a day and their faces at least once. Although most of the body is protected by clothing from the contaminating



A corner in an up-to-date bathroom

substances in the air, it is more likely to become contaminated by excretions of the body than are the hands and the face. Hence the whole body needs to be bathed frequently and thoroughly. whenever conditions allow—and conditions are rarely ever so unfavorable as to prevent—the bath should be taken daily. The bath is most effective and beneficial if supplemented with vigorous rubbing and kneading or massage of the body.



A swimming pool

What should be the temperature of the bath? As a rule the temperature of the bath should be as nearly as possible the same as that of the living room. About sixty-eight degrees is the ideal temperature for the morning bath. It may safely be a little lower or a little higher, according to the different seasons. A hot bath with soap is to be preferred for cleansing purposes to the cool bath with pure water. A cool bath with pure water and a little soap, however, if taken daily, will keep the body clean, even if the temperature of the water is

no higher than seventy degrees. For young children and infants the temperature of the bath should be about the same as that of the body. Very young infants should be bathed in water not under ninety degrees in temperature. Children of from one to two years should be bathed in water not under eighty degrees. For children over three or four years of age, the standard temperature of sixty-eight or seventy degrees is best.

Since the skin has a very important function in connection with maintaining the temperature of the body at the normal, and has many other important functions, it is to be considered in all the problems relating to health and should be given the greatest care to keep it healthy and in the best of condition.

XII. WATER AND ITS FUNCTION IN HEALTH

What is water? We have seen how the oxygen of the air unites with the hydrogen and carbon of the foods and of the tissues and produces water and carbon dioxide. Attention has also been called to the fact that if we place a piece of wood or coal on the fire, and it burns, much the same kind of "smoke" is produced as that which arises in the human body. In other words, the greater part of the "smoke" that goes up the chimney or comes out of the lungs is composed of carbon dioxide and water. When carbon dioxide and water are in the form of gas they are not visible. In the smoke that goes up the chimney the carbon dioxide and water are not visible; the smoke we see consists chiefly of such impurities as unburned carbon. Neither do we see the "smoke" that comes out of the lungs unless the air into which it is breathed is cold. The cold condenses the moisture and it then becomes visible. This also happens if we breathe on a cold polished surface, like glass or metal.

What is the chemical composition of water? Water is composed of two substances, known as hydrogen and oxygen. We have learned that oxygen is an important part of the mixture we

call air. But hydrogen is not present in the atmosphere under ordinary conditions.

Thus the air we breathe into our lungs may be said to contain no hydrogen except that in the watery vapor which is always present in the air.

What are some of the chief properties of water? We are so familiar with water that we scarcely ever think of trying to describe it. Water produces the condition we call *wet.* We are perfectly familiar with that condition. If we stand out in a rainstorm a little while our clothes are wet through and through.

Water also has the power of dissolving substances. If you put a piece of sugar in water it begins to dissolve rapidly. If you stir the water it will dissolve more rapidly. If you place the lump of sugar in a spoon and hold it just below the surface of the water it dissolves as rapidly as if the water had been stirred. If you make this experiment in a glass vessel, and hold it up to the light, you will see the melted sugar flowing down in currents through the water, although it is perfectly colorless. The sugar solution flows to the bottom because it is heavier than the water. It thus makes room at the top for the water that has less sugar in it, and the solution of the lump of sugar goes on with a greater rapidity. If you put a lump

of salt in the water the same thing will occur, but more slowly. Thus we say that sugar is more soluble in water than salt.

Does the temperature of water affect its power to dissolve substances? Yes, very markedly. As a rule hot water dissolves a greater amount of a substance than cold water, and does it more rapidly. In the case of common salt, however, the reverse is true. Cold water will dissolve salt more rapidly and in greater quantity than hot water.

Water dissolves almost everything with which it comes in contact. Thus the water that runs down through the rocks underground and flows out again in a spring will carry in solution traces of the rocks with which it has come in contact. If iron ores are present in the rocks the water will carry away traces of iron. If there is marble or limestone in the path of the water through the earth it will dissolve large quantities of these substances. And so with almost every other known substance. But there are a few substances that are extremely insoluble in water—for instance, such metals as gold, silver, and platinum, though under certain favorable conditions even tiny bits of these bodies may be found in water which flows through rocks. Water has been very properly called the "universal solvent."

What effect has heat on the volume of water? Heat affects water, as it does most other substances, by increasing the volume or amount. To prove this, fill a vessel with cold water and in the mouth of the vessel place a cork with a glass tube through it. Then set the vessel over the fire, and you will see the liquid mount rapidly in the tube. The water is expanded by the heat and is forced into the tube. The expansion continues until the water begins to boil.

How much water is there in the human body? The human body is practically three fourths water. The food we eat contains about the same relative amount of water as does the human body, that is, seventy-five per cent. Some foods contain a great deal more water. Milk, for instance, contains eighty-seven per cent. The cereals, on the other hand, when uncooked, contain only about twelve per cent. Refined sugar contains practically no water. But the proportion of water in our food as a whole is about seventy-five per cent.

How much water should we drink? This is determined largely by the feeling of thirst or desire for water. Thirst is nature's best way of telling us, through the nerves, that the body is demanding a larger supply of water. Thirst may be produced in many ways. If we eat a great deal

of salt or sugar, both of which require a considerable quantity of water to dissolve them, more or less water is drawn from the tissues with which these articles come in contact. This taking away of the water, usually from that in the stomach, produces a sense of thirst, which we gratify by drinking water.

The feeling of thirst is also usual in hot weather, because so much water is discharged from the body in the form of perspiration. If we play or work hard on a hot day we speedily become thirsty, for the quantity of water in the body is distinctly reduced by perspiration. It requires, moreover, only a very slight decrease in the quantity of water in the tissues to produce a sense of thirst.

Those who drink alcoholic beverages in considerable quantities also become thirsty. This is nature's way of telling us that these poisonous bodies should be diluted as much as possible. Like salt and sugar, alcohol also extracts water from the tissues with which it comes in contact.

There are many other things that cause thirst. Dry foods or overeating, especially of meats and highly seasoned foods, is a cause of thirst. A fever, or a bodily temperature higher than the normal, usually makes us thirsty.

Thus we see that thirst may be a normal condition, caused by physical exertion, hot

weather, or eating dry foods. It may also be an abnormal or unusual condition, as when it is caused by taking large quantities of salt, sugar, candy, meats, highly seasoned foods, and alcoholic beverages or drinks when ill with a fever. But whether the thirst is normal or abnormal the best plan is to drink water.

Is there any other method of quenching thirst besides drinking water? All kinds of beverages are used for the purpose of quenching thirst. Among them are the so-called "soft drinks." These drinks are made principally of sugar, burnt sugar or caramel, some aromatic or bitter principle, and water. They are usually very sweet, and are poor beverages to use for quenching thirst. Drinks to which substances such as caffeine, found in coffee, or cocaine, found in the

At the soda water fountain

coca leaf, have been added are also supposed to quench thirst. Coca Cola is a type of soft drink containing caffeine. Tea and coffee are said to quench thirst. Lemonade and orangeade and soda water are sold in large quantities to satisfy thirst. But none of these so well answers the purpose as pure spring water or any pure water of the right temperature.

What should be the temperature of drinking water? Unfortunately, it is the custom in the United States to use drinking water that has been reduced almost to the temperature of melting ice. It is common, especially in summer, to place ice in the drinking water. This is a harmful practice. Drinking water should be kept at a temperature not lower than fifty-five degrees and not higher than sixty-five degrees. At those temperatures it is extremely palatable and not at all injurious.

Ice-cold beverages should be avoided, especially during the hot days of summer, the season of the year when such drinks seem most agreeable. It is harmful to fill the stomach with ice-cold water when one is very thirsty and very warm.

> "Full many a man, both young and old,
> Has gone to his sarcophagus
> By pouring water icy cold
> Adown his hot esophagus."

What is meant by pure drinking water? By "pure drinking water" we do not mean a liquid that consists of nothing but absolutely pure water. Pure waters are extremely difficult to obtain. The purest are those produced by the condensation of steam from boiling water. But even such water may contain gases, which are carried with the steam. Moreover, the water may boil so violently as to send particles of other substances into the steam and so into the condensed water. Absolutely pure water can be obtained only by the most carefully controlled chemical operations. Distilled water on sale in drug stores is reasonably pure. The rain water which comes after it has rained a long while is almost pure, but not entirely so.

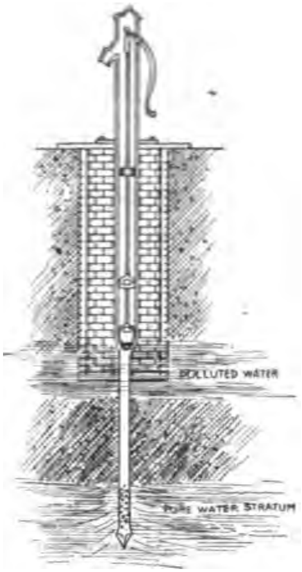


Diagram of a well

Pure drinking water really means water that is free from any dangerous infection and with only a reasonable quantity of dissolved matters. The purest natural waters are those which come from deep springs or wells situated in localities

where the rocks are highly insoluble and which are far removed from manufacturing industries and human habitations. The waters in springs found on uninhabited mountains may be regarded as types of the purest drinking waters. Water coming from great depths, as in artesian wells, is often reasonably pure so far as freedom from organic infection is concerned, but it is often highly charged with dissolved mineral substances.

Diagram of a spring

Absolutely pure water, even if it could be obtained in sufficient quantities, would not be the best for drinking. The dissolved mineral substances which are contained in spring and well water are favorable to health. Especially is this true of the lime, magnesia, and iron which such waters usually contain.

Are we well supplied with well or spring water? No, the greater number of people in the United States live in towns and cities. The water supply for the towns and cities is often taken from a near-by lake or river. Waters from such

sources are always more or less polluted. They carry, in addition to harmless mineral substances, large quantities of organic matter derived largely from manufacturing industries and from human habitations. Such waters are not pure, and many of them are dangerous for drinking.

How are these waters made suitable for use? In some places the waters are used for drinking without any purifying treatment. In such localities typhoid fever and other disease germs are sometimes found in the water.

The two principal methods of purifying the water of running streams and rivers to make it suitable for drinking are filtration and purification by chemicals. These two methods are often combined. The water is first treated with chemicals to start the purification, and is afterwards filtered. The filtering medium is usually sand. When infected or dirty water passes through the filter bed it deposits among the sand particles the fine material it carries, known as *silt* or fine mud, so that the muddy or infected water comes out of the sand filter reasonably pure.

Nearly all our large cities which get their water from running streams use some kind of a filtering apparatus. In many places the waters are first treated with chemicals to destroy the

organisms that are injurious to health. Lime, chlorinated lime, sulphate of iron, and alum are the principal elements used for purifying water.

How does such treatment of water safeguard health? Water purified for drinking purposes is practically free from disease-producing germs. Therefore such diseases as typhoid fever, cholera, and dysentery, which may be transmitted through water, are prevented if the water is purified. Severe epidemics of typhoid fever have been caused by a polluted water supply.

Polluted water in streams and rivers also injures the fish, oysters, and crabs that live there. Shad at one time entered the Hudson River in as great numbers as they do the Potomac. But the sewage of New York has polluted the waters of the lower Hudson and now few shad pass through to the purer water above. When these polluted waters are carried to oyster beds, the oysters themselves may become infected. Numerous cases of typhoid fever have been traced to the eating of oysters polluted by city sewage. All this shows the immense importance of a pure water supply to a city.

How much water should we drink at our meals? It has often been said by writers on health that it is not desirable to drink while eating, because the use of a beverage while chewing tends to

restrict the flow of saliva. Hence, since it is a vital necessity to mix enough saliva with the food to start the process of digestion, to drink a great deal while eating is injurious.

We should also learn to chew our food better than we have been doing. As a rule we swallow it too soon after we put it into our mouths, and the use of a beverage during mealtime encourages this habit. This is another reason why we should take very little liquid while we are eating.

Recent investigations have shown that to drink moderate quantities of water with our food does not seem to prove injurious, and may even promote digestion. When studying the process of digestion we find that it depends upon the action on the food of certain ferments. If the mass of food is too dry these ferments have difficulty in reaching it. If there is too much liquid, their activity is to that extent diminished.

If a person eats a very starchy food he should not drink water while eating, but he may do so immediately afterwards if he feels the need of it. Starchy foods are digested largely by the saliva and hence should be chewed as long as possible, so that the salivary glands—the glands that produce the moisture of the mouth—may act as vigorously as possible. In eating meat,

the saliva is not so important, and liquids may be used with less harm than when one is eating foods such as potatoes and bread.

In all cases, the drinking at meals of large quantities of liquids other than water, unless it be milk, is not advisable. It is better to wait until after the meal. Then we may drink water without injury to the digestive process.

It is certain, however, that articles of food, except succulent or juicy vegetables, do not contain enough water for the needs of the human body, and it is therefore desirable to drink additional water. The amount required varies greatly with the tastes and habits of the individual and the character of his food. If we eat succulent foods, such as turnips, lettuce, celery, asparagus, green peas, green beans, or green corn, we need very little additional water. If, on the other hand, we eat bread, meat, sugars, and oils, we need a great deal more water.

An abundance of water at the right time has a favorable effect on the digestion. It keeps the contents of the intestines from becoming too hard, and thus aids in preventing constipation. A good practice is to drink a few ounces of good water at a temperature of sixty to sixty-five degrees immediately on rising each morning and to take the same amount before going to bed at night.

In general, the degree of thirst determines the quantity of water that should be drunk. You are not likely to injure your health by drinking too much water, if it is pure and of the proper temperature.

What happens if you drink more than thirst requires? Usually a little more water than is normally required to satisfy thirst will not prove harmful. The healthy body keeps the proper balance of water in the blood. If a little too much water is taken, it is eliminated without much trouble through the kidneys, through the skin, and in other ways. But in diseased conditions of the body, as in a hardening of the arteries or in diseases of the heart, an excess of water may prove harmful. The excretory organs are then unable to do their full duty, thus increasing the volume of the blood and throwing an additional burden on the heart and the imperfect arteries. These diseases do not usually attack children or young people, but are common in later life. People past forty or fifty years of age, whose blood pressure is above the normal, should limit the quantity of liquids in their foods to the smallest amount necessary for proper digestion. This is a matter to be decided by the physician and not by the schoolbook.

Is water used as a medicine? The use of water

in keeping clean is to a certain extent medicinal. Washing the hands is distinctly an attack upon disease, for clean hands are less liable than dirty hands to carry disease to the mouth or to impart disease to others. The common habit of washing the hands and face in the morning is to be commended from a point of view both of cleanliness and of health. It is well to repeat this operation at noonday and at night.

The bathing of the whole body is likewise a health measure. Water and a little soap, the rubbing which one receives in bathing, and the drying with a coarse towel, tend to promote the healthy action of the skin. These things all help to supply the body with the proper amount of blood, and to keep the pores open and in condition to perform their normal functions. For the same reason massage—the kneading and pounding of the body—is also conducive to good health. The use of water, therefore, is one of the most valuable methods of preventing disease, for through water we secure cleanliness.

Is water ever used in sickness? Water is constantly used as a remedy by physicians. Because of its great power of absorbing heat it is used very generally in cases of fever, either in the liquid state or frozen. Bathing the body

of a person suffering from fever cools the surface of the body and is refreshing to the patient. Copious drafts of water, usually warm water, are used internally to produce vomiting. If a little salt is added to the water, it acts more promptly. For this purpose the water should be lukewarm, neither very hot nor very cold.

What is meant by "taking the waters"? Those persons who go to drink the waters from mineral springs which are reputed to be of value in certain diseases are said to be "taking the waters." When people go to the springs they are placed on a rigid diet, usually very simple, consisting of a little fruit and hard bread, the water of the spring being their only beverage. The waters at such springs are usually known as mineral waters; that is, they contain more of the materials derived from rocks than ordinary spring or well water. These materials or mineral substances have a medicinal action. The water contains more or less lime, an excellent remedy for many diseases. The benefit which people secure at the springs is probably due as much to the rigid diet on which they are required to live as it is to the use of the mineral waters themselves.

Could life be continued without water? Water is as necessary to a living being as air or food. If you were deprived of water you would die as

quickly as if you were deprived of food, or even more quickly.

If you have plenty of food, even though it is dry, a good deal of water will be generated when the food is eaten, because all the hydrogen which the food contains will be burned into water in the body. But even that quantity of water is insufficient to support life for more than a short time. The average amount of water in the ordinary foods we eat is about seventy-five per cent, but even with so much water we are required constantly to take additional quantities. You can readily imagine what would happen if all our foods were entirely dry and we had no access to water. We should live only a few days.

Long ago the Latins had a motto which, when translated, reads: "Bodies do not act unless they are in solution." Water, as has already been said, is the universal solvent. All the foods we eat must pass into solution in water before they can be taken up into the blood.

PART TWO

XIII. Food and Why We Need It

What is food? This is a very important question. Food is necessary to life. Without it we should soon die of starvation. The work men do is largely done in order to obtain food. Food is necessary also to health and growth. Without proper food the child cannot grow as he should. No one, young or old, can be healthy without suitable food. Every one who studies, plays, or works must be properly nourished. In all plans for life and happiness, food must be considered.

Every person is at his best only when supplied with pure food. The family cannot do its work at home or in society unless it is supplied with good food. The community cannot become prosperous and progressive without good food. The state would fail in its efforts to establish good government and protect the rights of its inhabitants without an abundant food supply. The nation engaged in war cannot continue fighting for any length of time without a large food supply. The most progressive races of men are those that have good food in plenty. Thus, from every point of view, we

find that food, above all things except air and water, is necessary to life, to effective work, and to happiness.

For this reason the answer to the question, What is food? is of great importance: *Food is that which, entering the body, promotes growth, restores waste tissue, and provides heat and energy.*

XIV. · The Articles of Food

What are the articles which serve as food? We all know from everyday experience what is generally regarded as food. When we speak of food we think of milk, bread, meat, fruit, vegetables, for the food we consume consists largely of these articles. There are still other articles which serve as foods though they are not usually thought of as such. In the first place, water forms an important part of the foods we eat. And, in that sense, water is a food, though we usually speak of it as a *beverage*. Again, the oxygen of the air plays an active

The interior of a market

part in nourishing the body, and especially in providing heat and energy. To that extent

the oxygen which enters the lungs is really a food, though it is not included under what we commonly term food.

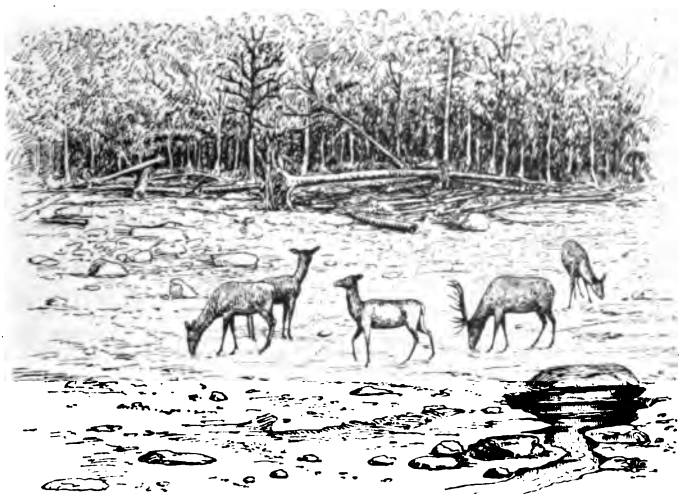
There is another class of articles, called *condiments*, used chiefly to give relish or seasoning to food. Some condiments are foods and others are not. Common salt, for instance, is a condiment; but it is also a food, since it is necessary to the proper nourishment of the body.

Is common salt hurtful? When used in too large quantities common salt, instead of being useful, becomes harmful. This is true of every good substance. You can drink water enough to dilute your blood. This increases the bulk of the blood, thus imposing an unnecessary burden on the heart, the arteries, and the veins, and on the kidneys and other *excretory organs*, which separate or discharge waste and harmful material from the blood or tissue. In this way water becomes harmful. You can eat enough bread to overload your stomach and thus produce indigestion and do harm. You can drink so much milk that you will be made ill. And so with every good thing. Its right use is beneficial; its wrong use is harmful.

There is a great difference between articles which are useful and good when not used to excess, and those which in themselves are useless and also harmful. Because common salt

becomes harmful when used to excess is no excuse for the use of such a substance as *benzoate of soda*, a common food preservative, which never does any one any good no matter what the quantity used. A useless substance in the body, no matter how small the quantity, must be harmful since the energy of the body must be used in some way to get rid of it. In the long run any useless expenditure of energy is harmful.

Are we in danger of eating too much salt? Salt is often used in foods which would be better



Deer at a salt lick

without it. An instance of this is its use in butter. In this country we are accustomed

to salted butter; in other countries it is served unsalted. If we used unsalted butter we might soon learn to like it better than when salted.

We are also inclined to use too much salt on our meats. The proper place to use salt is with our vegetable foods. Animals that live on vegetables require more salt to enable the organs of the body to perform their proper functions than those that live on meats. Wild plant-eating animals, such as the buffalo and the deer, will travel many miles in order to reach a salt lick, a place where salt is found on the surface. Those of you who live on farms are familiar with the general custom of giving salt to sheep, horses, and cattle. On the other hand, flesh-eating animals, such as dogs and cats, do not require much salt. This is because there is naturally much salt in all flesh and very little in vegetables, and because plants contain much potash which common salt helps to eliminate.

A farm smokehouse

The desire for an excessive amount of salt in our food is largely a matter of habit which can easily be overcome.

Are there other condiments in foods? There are many condiments besides salt used in foods. Some of these, such as mustard and some forms of pepper, have a certain amount of food value. Others, such as vanilla and other flavoring extracts, have little or no food value. The principal condiments are salt, pepper, mustard, cinnamon, ginger, and the flavoring extracts.

A particular flavoring substance is developed by burning wood. This substance, which is present in the smoke from the burning wood, is regarded as a condiment and is usually classed as such. Ham and bacon owe their flavor in part to this condiment.

Not salt alone, but all condiments, may become injurious if used to excess. But when properly used they are beneficial, for condiments induce an increased flow of the liquids that aid digestion.

XV. The Flavor of Foods

What is flavor in food? Flavor in food is a combination of taste and odor. We get it through the combined action of the tongue and the nostrils. It is not correct to say that we get the flavor of food through the mouth alone or through the nose alone. What we get in the mouth is the taste, and what we get through the nostrils is the odor; the combination of the two is flavor. For instance, sugar has a taste but no odor, and vanilla is especially valued for its odor, but the use of a combination of sugar and vanilla gives us a cake with a pleasing and distinct flavor.

Flavor is an important element in the proper digestion of food. If we were to take our food through a tube inserted into the stomach, which is entirely possible, we should get from it neither a sense of smell nor a sense of taste. At the same time our digestion would be greatly impaired and the food would not properly nourish the body. Thus the forcible feeding of prisoners who try to commit suicide by starving themselves may save their lives, but it does not give them the full benefit of the food.

Condiments all affect either the sense of taste or the sense of smell, and usually both.

Condiments, therefore, are important aids to digestion, because they produce or heighten food flavors.

Do foods themselves have flavors? Yes, most food products have flavors. Those that have well-marked flavors do not need the addition of a condiment. Good types of such foods are the apple and the citrus fruits. These products have not only an agreeable odor but also a pleasant, sweet-acid taste. This combination of odor and taste produces a fine flavor.

No one should think it necessary to add any condiment to such fruits in order to produce flavor. The addition of pure sugar is not the addition of a flavor, because refined sugar, having no odor, does not fall within the definition of a flavor. When cooked, acid fruits are often sweetened, and sometimes condiments, like cinnamon or nutmeg, are added for flavoring purposes. But in the raw state, and it is thus that the fruits present their best flavors, such additions would be out of place. Practically none of the common foods that we eat in the raw state need condiments. Melons, berries, and nuts all have distinctive flavors and are for the most part eaten without condiments. Some nuts are improved to the taste of many persons by the addition of salt, but few are really made better thereby.

Does cooking develop flavor? Cooking or roasting develops flavor in a great many substances without the addition of condiments, though it is the cooked foods, most of all, to which condiments are added. Some notable examples of the development of flavor by roasting are found in coffee and in peanuts. The peanut, though edible in the raw state, is far more agreeable to the taste when roasted. The roasting develops taste and odor—that is, flavor. The coffee bean has a better and an entirely new flavor after being roasted. In fact, a drink made from the raw coffee bean would not appeal to the taste. The flavor of meats is always brought out to a great degree by roasting. This is true also of the baking of bread.

A street peanut roaster

Condiments affect the nerves of taste, which are in the tongue, and also the nerves of smell, which are found in the nostrils. These nerves are connected directly

and indirectly with the digestive organs. A good taste and a good odor in food aid in exciting the activity of the digestive organs.

Jaw and mouth, showing salivary glands
a, parotid glands; *b*, submaxillary glands; *c*, sublingual glands; *d*, salivary glands; *e*, tongue

When you are very hungry, and you get the odor of the dinner being cooked, your mouth waters. That is, the nerve of smell — the *olfactory* nerve — has carried a message to the *salivary* glands that something good is coming, and these glands, which discharge saliva into the mouth, get ready to welcome the visitor. In other words, your "mouth waters." Then when you place on the tongue a bit of food that tastes good, the nerve of taste sends a message to the glands in the stomach that secrete the *pepsin*, and those glands get ready to aid in digesting the food. If you put butter on your bread and get both the taste and the odor of butter, these nerves send a message

to the large gland called the *pancreas*, which discharges into the intestines, and the pancreas prepares to welcome the visitor by secreting the fluid which will digest the fat. Thus, through odor and taste, all the organs which are active in the digestion of food receive advance notice of the approach of the food and make preparations to do their part in its digestion.

Is there danger in using condiments too freely? The answer to this question is the same as that in regard to salt. In order to avoid excess, condiments should be used sparingly, with judgment, and with great care. The delicacy of flavor secured by the addition of a condiment should be one of the chief recommendations for its use. The skilled French cook, instead of putting onion directly into his sauce, will simply rub the spoon with which the sauce is served with an onion. He thus gets a fine, delicate flavor, instead of the full strength of the onion. The proper use of condiments is a mark of the skilled and experienced cook. Those not skilled in the use of condiments may make up

The onion plant

for their lack of knowledge by using very small quantities.

The ability to use the heat of the oven in developing taste, odor, and flavor is also a marked characteristic of the good cook. Out of similar raw materials two persons may each bake a loaf of bread, one of which will be attractive, palatable, and digestible, and the other unattractive, unpalatable, and indigestible.

"Ruby" pepper

Are condiments regarded as food products? Condiments are not commonly regarded as food products although legally, they are. Everything we use for our nourishment or pleasure, legally is regarded as food. The Food and Drugs Act of the United States defines food as not only that which is usually considered as food, but also beverages, condiments, and confections. This law is usually called the "pure food law" because it requires that all articles of food made or put up for sale be clean and pure.

XVI. Differences in Foods

How do foods differ? No two foods are exactly alike. Even if of the same variety there may be great differences between them. All the foods we eat, even those of the same kind, vary according to the locality in which they are grown and the conditions of climate or season and the methods used in harvesting and handling them. A pippin (one kind of apple) grown in Virginia may be quite unlike a pippin grown in California, though both apples grew on the same kind of a tree. The environment in which food grows — in other words, air, sunshine, rain, and soil — has a great deal to do with its character as well as the kind of food it represents.

An apple

Foods differ in many other respects. It is very important that we understand in a practical and simple way just what some of these differences are.

What are the most common articles of food? In general, when we sit down at a table we expect to have bread. A meal without bread, though such meals are sometimes served, never seems quite complete. Especially is this true of

the home table. Bread may be considered a universal food among all nations where the art of bread making is known. Under the term "bread" we include the many varieties of foods made from such cereals as wheat, Indian corn, oats, and rye.

Another article we usually expect to have at a meal, especially at dinner, though it is not so universally eaten, is meat. Under the term "meat" we may include as many different kinds of products as we do under the term "bread."

A third article we usually have at a meal is a vegetable of some kind. In common language the term "vegetable" is not applied to all plant-food products. Potatoes, green peas and beans, radishes, and beets are recognized as types of the class of foods we commonly call vegetables.

Oranges

Our ideas of a meal, in other words, lead us to think at once of three great classes of food: *bread*, *meat*, and *vegetables*. It would not be fair to leave out fruit, although fruit is not nearly so commonly served at meals as vegetables. It

would be well if it were used more. A true saying is, "An apple a day keeps the doctor away." It is unfortunate that so large a number of our people do not have the privilege of eating fruit every day. It would be wise for the one who provides for the table to serve less meat and more fruit and vegetables.

May foods be classified in other ways than as bread, meat, vegetables, and fruit? These terms, bread, meat, vegetables, and fruit, are used to denote the articles usually thought of as foods. But regarded from the scientific point of view, the term "food" applies to the elements of nourishment rather than the articles in which these elements exist in combination.

We have in our bodies certain tissues — namely, bones, muscles, tendons, nerves, brain, skin, and hair. These tissues have different characteristics; that is, they are made up of varying amounts of different kinds of elements and require different kinds of nourishment. The scientific view of nutrition is to feed these tissues the elements of nourishment they need, selecting from among the different articles of food those things which most nearly supply their wants.

There are four principal foods, or elements of nourishment, necessary to the sustenance of the body. First, starches and sugars, together

known as *carbohydrates*, a word which means "water united with carbon."

Sugars are much more *soluble*, or easily dissolved, than starches. They are extremely soluble in water, while starches are scarcely at all soluble in cold water and only to a limited degree in hot water. If you boil a little starch with water it is apparently dissolved, but the fact is the starch is suspended in the water in the form of a paste. But, if you put sugar in water the sugar rapidly disappears, and exists throughout the water in a state of complete solution.

As foods, sugars and starches are much alike; they serve the same purpose in the body, and together they constitute by far the largest part of our food.

What are the principal starch foods used? The cereals — wheat, corn, barley, rye, rice, oats, buckwheat — form with potatoes the principal food supply of man. They are also the most important starch foods he uses. In some countries cereals provide almost all the food supply, as in the rice-eating countries of China and Japan. In other countries the principal article of food is made from rye, as in Russia and in parts of Germany. In still other countries the principal cereal products used for food are wheat and oats, as in France, England, Scotland, the United States, and Canada.

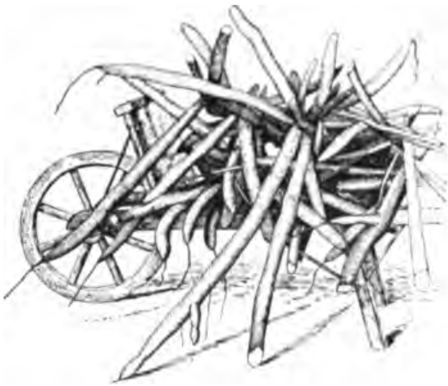
Cereals in general, when ground into flour or meal, contain seventy per cent of starch and twelve per cent of water, although certain cereals vary somewhat from these figures. Thus it is evident that when cereals are eaten the great bulk of the food is composed of starch.

The sago palm

Among other starch foods the potato contains about twenty-two per cent of solid food and seventy-eight per cent of water. Of the twenty-two per cent of solid food more than three fourths is starch. Peas and beans also contain considerable quantities of starch, though in these articles the starch is not the principal ingredient. There are certain other foods — such as the *cassava*, which grows in Florida and the tropics; the *taro*, a starchy food which grows abundantly in the Hawaiian Islands; and *sago* — the food elements of which consist largely of starch.

Thus we learn that the principal starch foods are cereals, potatoes, sago, cassava, and tapioca.

From what products do we get the principal sugar foods? Practically all the foods we eat contain sugar. Some of them, such as the cereals, contain an exceedingly small quantity of sugar, not over one or two per cent. Others, like the refined sugars of commerce, consist almost entirely of sugar, the percentage being 99.95. We eat sugar in two forms, first as an element of our common foods. In this we have no choice; we must eat the sugar if we wish to eat the foods. Second, we eat sugar that has been extracted from plants and prepared for our use in the form of molasses, sirups, raw sugar, and refined sugar. We eat these simply as sugars, or after they have been added to pastry, confections, and candies.



Cassava roots

Among the foods that are rich in sugar, milk may be mentioned first. Milk contains from five to eight per cent of sugar, according to the kind used. Ordinary cow's milk contains about five per cent of sugar. Beets, especially sugar

beets, contain a large amount of sugar, sometimes as much as fifteen to eighteen per cent. Turnips, radishes, and carrots contain from two to five per cent. Fruits of all kinds contain a large amount of sugar, from seven to fifteen per cent, and some kinds of grapes contain even more.

A sugar beet

Thus, whether we eat cereals, drink milk, or eat vegetables or fruit, we are continually taking into our stomachs large quantities of sugar. When we eat cakes, pastry, confections, and candy we take still greater quantities. Some of these latter foods are composed almost entirely of sugar. So far as digestion and nutrition are concerned, sugar and starch have the same properties and may be considered as one and the same substance.

What relation has sugar to health? A large amount of sugar in the food tends to make one fat. Sugars and starches are regarded as even more likely to cause *obesity* or stoutness than fat or oil. People who are inclined to become corpulent should eat as little sugar as possible. They should not put it on the cereal at break-

fast or use it with strawberries and cream at lunch, and they should avoid ice cream at dinner because of it. An excess of sugar in the body, though it is fattening, is injurious to health. The alarming increase in this country of the disease called *diabetes* may possibly be due in a degree to the largely increased consumption of sugar per person. For the same reason candy eating among children is extremely threatening to health. Sugar may make children fat, but it does not make them healthy. They get all the sugar they need in their usual food.

After starch and sugar, what is the next important food element? Judged by the quantity in which it occurs in food products, the most important food element after the carbohydrates, starch and sugar, is what is known as *protein*, the main part of white of eggs, gluten of wheat, and lean meat. Protein is the name given to that class of foods, so important in human nutrition, which contains as two of its distinctive elements *nitrogen*, meaning "niter producer," and *sulphur*. Many of the proteins contain other important nutrients also, as for instance *phosphoric acid*, present in bones and teeth. A pure protein, however, may not contain any phosphoric acid, but may consist entirely of nitrogen, sulphur, hydrogen (water former), carbon (coal), and oxygen (acid former). Usually a pure

protein, such as dried white of egg, which is about the purest form known in nature, contains about sixteen per cent of nitrogen and one per cent of sulphur. The other eighty-three per cent are composed of hydrogen, oxygen, and carbon. The principal sources of the protein in our foods are the cereals, and after them especially lean meat, red or white, of all edible animals, and lastly eggs, peas, and beans.

What is the third important food element? Judged by quantity alone, the third important food element is fat or oil. Fats and oils comprise nearly all the butter and lard, olive oil, cotton-seed oil, and other edible oils which we consume with our foods. Of the different parts of the hog, the bacon is almost all fat, while the ham is mostly protein. Butter is an important fat food, more than eighty per cent of it being pure fat. Many nuts also are composed largely of oil; for instance, the peanut is about forty per cent oil. The same is true of the almond and the walnut. On the other hand, the chestnut contains a large amount of starch as well as a considerable quantity of oil. So in eating nuts one gets, as a rule, a large quantity of oil.

What is the next most important class of food elements? Again judged by quantity alone, the fourth and last class of food elements consists

of what we call "mineral substances." When a food substance is burned, the ash that is left represents the incombustible mineral matter that the food contains. The quantity of ash in food products varies greatly. Some foods contain as high as three or four per cent of ash, while others contain less than one per cent. This mineral matter consists of various substances, certain of them being important to nutrition. Among these are *phosphorus* and *lime*, which are used in the body to form a considerable part of the bones and the teeth. The other minerals play parts of greater or less importance. Thus we see that the mineral elements of food, although least in quantity, are quite as necessary for proper nutrition as the larger quantities of fat, protein, and starch which our food contains.

In a general way it may be said that for every one hundred pounds of food we eat, two pounds should be mineral substances. Among these phosphorus, sulphur, chlorine, lime, iron, magnesia, salt, soda, and potash are the most important.

Are the acids which exist in foods of value in nutrition? The acids found in certain food products play an important part in nutrition. They are to be classed with the condiments, and thus become food products. The acids found

in certain kinds of fruit are also very generally distributed in all vegetable substances, though only in small quantities.

Cutting sugar cane

In the sap of sugar-producing plants, as sugar cane, sugar beets, and sorghum, and in the sap of the maple tree, there are large quantities of acids. Usually they are what is termed *malic* acid, that is, the acid of apples, although not exclusively so. Other vegetable acids are frequently found in sugar-producing plants of this kind but in small quantities. *Citric* acid is found in lemons and oranges, and *tartaric* acid in grapes. All these acids in fruit are combined with a base, principally potash.

Because these acids improve the taste of the foods in which they are found, they are condiments. When these vegetable acids are digested they produce a certain amount of heat, and hence, like sugar, they have a food value as well as a condiment value. They also perform a useful service in carrying the soda and potash they contain into the body.

XVII. A Study of the Articles of Food

How may we know of the distribution of the four principal elements of nutrition? The answer to this question is of great practical value. If we wish to keep well and be as efficient as possible we must not only know something of the nature of foods but, in order to secure the best results, we must know how to use them in a practical way. It would not be possible for us to weigh and analyze each portion of food set before us. Fortunately, we do not need to do this, for nature is quite consistent in her work, and from year to year and from generation to generation makes foods of the same kind practically alike. So we need only know the average composition of any staple food product to determine the correct proportion of that product that should be eaten.

In order to be able to do this effectually we shall study some of the more important food products that are daily set before us. Each kind of product contains, in a proportion peculiar to itself, the elements of nutrition already noted.

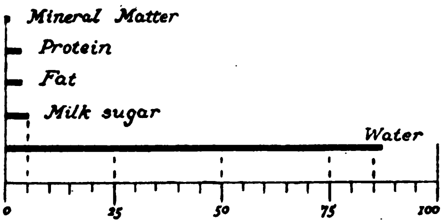
What is the average composition of milk? In our country the term "milk," when used without qualification, means milk of the cow. Cow's

milk has been analyzed thousands of times in this and other countries, so that we know with practical exactness its average composition. This is set down in the following table:

THE COMPOSITION OF COW'S MILK

WATER	MILK SUGAR (LACTOSE)	PROTEIN (CASEIN)	FAT (BUTTER)	MINERAL MATTERS
87 per cent	5 per cent	3.4 per cent	3.9 per cent	.7 per cent

One hundred pounds of milk furnish thirteen pounds of food in a dry state. These thirteen pounds of food contain the various food elements in the right proportions to furnish an ideal ration for the growing child, and especially for the infant. Attention is called to this fact for the reason that in its composition milk is a model for selecting the food of the child after his teeth are developed and he ceases to be nourished wholly by milk. If this be a true guide, and there seems to be no doubt of the fact, then in choosing food for the growing child we should see that it contains all the elements of growth in about the same proportion as they exist in the dry matter of milk. Then from the above table we may obtain the following



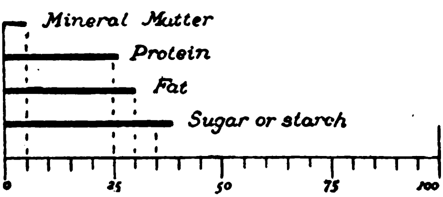
Composition of cow's milk

table of proportions of the food elements in milk, excluding the percentage of water.

IDEAL COMPOSITION OF FOOD FOR THE GROWING CHILD IN PARTS OF 100 OF DRY MATTER

SUGAR AND STARCH	PROTEIN	FAT	MINERAL MATTER
38.46 per cent	26.16 per cent	30 per cent	5.38 per cent

There are traces of various other substances in cow's milk, but these are so small in quantity that they need not be considered here. In order to simplify the above table, and make it more easily remembered, we may say that when making up a diet for children that part of it other than milk should be in the following proportions: The protein should be five times the quantity of mineral matter; the fat six times the quantity of mineral matter; and the sugar and starch eight times the quantity of mineral matter. Representing the mineral matter by 1, we have the following series of numbers: 1, 5, 6, 8. These figures are easily memorized.



Ideal composition of food for the growing child

MINERAL MATTER	PROTEIN	FAT	SUGAR AND STARCH
1	5	6	8

They represent the food elements in the relative proportions in which they should be present in the food of the growing child.

Is there any food product which can take the place of milk for the growing child? Yes, there is a common food product which is almost as well adapted for the growing child as milk. This food we call cereal, and it is advisable to use it in connection with milk for children beyond the age of infancy. The typical cereals are wheat, Indian corn (maize), rye, barley, rice, oats, and buckwheat. But children especially should eat a great deal of milk with cereals. Wheat is the best cereal, although alone it produces too much acid; milk corrects that fault.

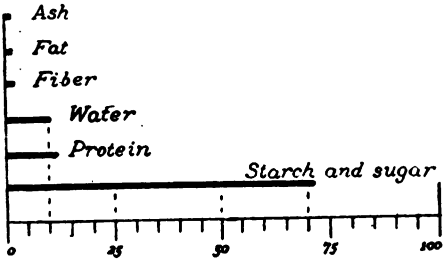
Milking the cow

What is the average composition of wheat? Wheat is rightly regarded as the most valuable of the cereals used for bread making, and its composition should be known to every one.

AVERAGE COMPOSITION OF WHEAT

	GRAMS[1]
Weight of 100 grains of wheat	3.8
	PER CENT
Moisture	10.50
Protein (gluten)	12.25
Fiber (indigestible)	2.40
Fat	1.75
Starch and sugar (principally starch)	71.35
Ash (mineral substances)	1.75

From this table we learn that wheat not only contains all the elements of nutrition necessary for the growth and sustenance of the body, but that these elements are present in the most suitable proportions. In fact, the elements in wheat, so far as they are digestible, exist in such proportions as to nourish all the tissues of the body as they should be nourished. But eating wheat alone is not advisable. It produces too much acid. If you will compare the composition of wheat with that of milk you will learn that wheat contains a much smaller quantity of fat and a much higher quantity of starch and sugar. The



Average composition of wheat

[1] The nickel, or five-cent piece, weighs exactly five grams. It takes about 150 kernels of wheat, 215 kernels of rice, or 170 kernels of oats to equal the weight of a nickel.

digestive organs of the infant are not suited to the digestion of starch. On the other hand, they are suited to the digestion of the fat which is in milk, and there is a comparatively larger quantity of that substance in milk. The growing child and the grown man can digest starch readily, and in the cereals nature provides a food product containing large quantities of starch. Therefore, after the period of infancy, cereals are well suited to the growing child.

A wheat head

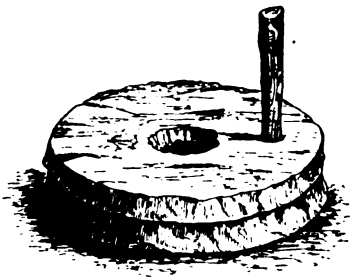
But it is well to remember that all wheat has not exactly the composition given in the table. Wheat recently harvested contains considerably more moisture than is given in the table. When wheat has been kept for a long time in a dry granary, and especially in a dry country, the amount of moisture is less than that given in the table. Whenever the moisture varies one way or the other, all the other ingredients vary inversely. By this we mean that when the percentage of moisture increases, the percentage of all other ingredients decreases.

How is wheat best used for food? On account of its extreme hardness, and the smallness of the kernels, wheat in its natural state is not

suitable for food. It is true that persons with good teeth can chew wheat readily, but as a rule there is such difficulty in chewing the kernels that it has led to the preparation of wheat in forms more suitable for eating.

Old and new ways of grinding grain. In primitive times grain was crushed between stones by hand. The natives who inhabited this country at the time of its discovery by Columbus prepared their grain in this way. As civilization

Indian grinding stones



The quern. First form of grinding mill

advanced, better methods were needed. This led to the development of the old-fashioned millstone. Millstones are made of hard, gritty stone so adjusted that one stone revolves against the other, crushing the grain between them.

In the modern roller mills, millstones are not used in grinding grain. In such mills, iron or porcelain rollers have taken their place, and from grain to finished product the material is not touched by hands.

Grades of flour. There are several grades of flour. The term "patent" is used to designate the product of greatest whiteness and commercial value, while other names signify lower grades, such as Bakers' Flour, Family Flour, and Red Dog. The term "Red Dog" is applied to a flour of low grade, that is, so far as color is concerned. Although it is not perfectly white, it contains a larger portion of important nourishing ingredients than does the white patent flour. In the process of milling, the germ of the wheat kernel and the hard fibrous covering of the kernel, called bran, are removed. These materials are then sold separately for cattle foods under the names of *bran* and *shorts* or *middlings*, and the various grades of flour, made from the inner part of the kernel, pass into commerce for use by bakers and housewives.

How does the milling process affect the nutritive value of wheat? The process of milling has a most decided effect on the nutritive value of wheat. Unfortunately, the public taste, probably helped along by the attitude of the millers, demands a flour of extreme whiteness. To meet this demand the miller strives to make his flour as white as he possibly can. Since the advent of the steel roller mill he is able to produce a much whiter flour than he could

under the old system of grinding the grain between millstones. But the wheat germ, which is discarded in the process, contains a large quantity of phosphorus and oil, and this oil is a food of high value for producing muscular power and heat. The bran, which is also discarded, is particularly rich in lime, phosphorus, and potash, elements of much importance in the nourishment of the body. It is also rich in protein, but because of its hardness and the quantity of fiber it contains, the wheat bran cannot be completely digested by the human digestive organs. On the other hand, the presence of the bran, when ground fine with the flour, has a most excellent effect in securing a proper movement of the contents of the digestive organs.

A great many of the world's best students of diet believe that whole-wheat flour — flour which contains the entire grain finely ground — is more wholesome and more nourishing than fine white flour. Other experts maintain that white flour is more completely digestible than whole-wheat flour, and for that reason should be preferred. My opinion is that for growing children especially, the whole-wheat flour is much to be preferred to white flour. Whole-wheat flour provides the special nourishment needed for the bones and the teeth, a nourishment not to be found in white flour. If young

chickens are fed nothing but white flour they do not grow and flourish. If they are fed whole-wheat flour they grow rapidly and keep in excellent health. Even in the case of grown men and women, whose bones and teeth are already formed, bread made from whole-wheat flour is not only nourishing but palatable.

My view is, then, that growing children should be fed on whole-wheat flour, or some other whole cereal, though grown men and women can occasionally, and even frequently, eat the products made from white flour without noticeable injury to health.

Can human beings live on wheat alone? Yes, it is possible to maintain life for a long time and apparently be well nourished, and yet eat nothing but wheat. But the human taste and the need for alkali — that is, soda and potash — demand a variety of foods in order to keep the digestive organs at their highest state of efficiency. In other words, we become tired of eating one thing only. We may like that one thing very well for a short time, but finally, if we have nothing else to eat, we grow tired of it. The food that we would tolerate alone for the greatest length of time is probably wheat and its products. What is said of wheat to a certain extent may also be said of the other cereals.

Next to wheat, what is the most important cereal used as food for human beings? Judging from its use as a food in the United States, the most important cereal next to wheat is Indian corn or maize. Maize, or corn as it is commonly called in this country, is by far the largest cereal crop of the United States. For every bushel of wheat grown in the United States, about four bushels of corn are produced. Corn is used as food for human beings in all parts of the country, but the amount so used is probably considerably less than the amount of wheat used for the same purpose. Corn is used most extensively as food for hogs, horses, and cattle. Practically all the pork produced here is fattened on corn.

An ear of corn

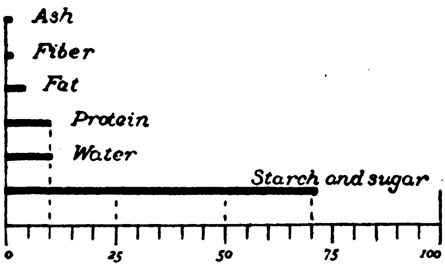
Indian corn is not very extensively used as food for human beings in other parts of the world. But in the Balkan States and Italy in the southern part of Europe where it is grown, its use is increasing. Indian corn is so called because it was first found commonly cultivated by the Indians in North and South

America at the time of the discovery of the new world.

THE AVERAGE COMPOSITION OF INDIAN CORN

	GRAMS
Weight of 100 grains of corn	3.8
	PER CENT
Moisture	10.75
Protein	10.00
Fiber (indigestible)	1.75
Fat (oil)	4.25
Starch and sugar	71.75
Ash (mineral substances)	1.50

What are the chief differences between Indian corn and wheat? Though the elements that make up corn are apparently the same as those that go to make up wheat, there is much difference both in the quantity and in the character of these elements in the two cereals. As far as moisture is concerned, wheat and corn are almost alike. But corn contains much less protein than wheat. The average proportions are ten per cent in corn and about twelve per cent in wheat. There is also a great difference in the protein itself. The wheat protein consists largely of those



Average composition of Indian corn

elements which, when mixed with water, unite to form what is known as the *gluten* of wheat. This gluten makes it possible to knead wheat flour into a loaf that will hold together and at the same time be somewhat elastic. The protein of Indian corn does not have this sticky quality. It contains practically none of the substance known as gluten. The principal protein of Indian corn is known as *zein*. Another striking difference between Indian corn and wheat is that Indian corn contains much more oil than wheat does.

Thus it is seen that while Indian corn is highly nutritious, in its composition it is distinctly different from wheat. It is much less valuable than wheat as a food for young people or young animals. Experience has shown that if pigs be weaned when quite young, so that they get no milk, and are then fed exclusively on Indian corn, they fail to grow; they become emaciated, their hair drops off, and finally many of them die. This is not the case with pigs that are fed on whole wheat. It has been found that the chief trouble is in the zein. While zein has a high value as a nutritious element for grown people, especially when mixed with other forms of protein matter, it does not promote growth. But if milk is used with the corn, then the zein becomes very valuable as a

food. Thus if children are given Indian-corn products to eat, such products should always be served with milk. On a diet of mush and milk children thrive.

If Indian corn, therefore, were the only article of food we could get, we should be much less effectually nourished than if wheat were our only food.

What is corn meal? Corn meal is the term applied to finely ground Indian corn. But the particles of corn meal are much larger than the particles of white wheat flour. It has been a very common practice, until within the last few years, to grind the entire grain to make whole corn meal. Thus the outer envelope of the grain, and the germ, which is so rich in phosphorus and oil, were retained in the meal, making it more nutritious than if these elements had been removed.

But it has been found difficult to transport and keep whole corn meal for any length of time, because it molds quickly when moist and soon becomes rancid because of the large amount of fat it contains. The term "rancid" is applied to the sharp, bitter, disagreeable taste of an oil which is partially decomposed. For this reason in the last few years millers have been grinding corn in the same way that they grind wheat flour. They take off the outer

hull and remove the germ, and thus make a corn meal which has much better keeping qualities but less valuable nutritive properties than the whole corn meal. In order to keep corn meal fresh for transportation it is dried.

The best corn meal, so far as nutrition is considered, is the freshly ground meal made from the whole corn grain.

What are the relations of Indian corn to health? In many parts of Europe people think that Indian corn is not fit for human food. I have already spoken of the fact that corn meal very easily molds when moist, or becomes rancid because of the large percentage of fat it contains. In this condition corn meal has sometimes been found to be poisonous. Some people have also claimed that the skin disease called *pellagra*, which has now secured a foothold in this country, is caused by eating musty corn meal. However, all evidence goes to prove that Indian corn meal does not cause pellagra, but that the disease is due to poor nutrition, perhaps to living almost entirely on carbohydrate food.

From the above it is clear that in its relation to health Indian corn has not quite so good a character as wheat. But when it is ground whole so as to retain all the elements of the grain, and is kept in a proper way, its value as

a food product is high, especially when eaten with milk, or other protein substances such as egg, lean meat, or peas and beans. In this case it does not in any way tend to derange or destroy health or induce disease. Its more general use as human food can therefore be highly recommended.

In what forms is Indian corn eaten? Many food preparations can be made from Indian corn. The simplest of all is "mush," or "hasty pudding." Corn meal is also used for making bread. In a large part of our country, especially in the South, bread made of corn is a staple food. Corn is also made into hominy, and into many varieties of breakfast foods. Thus Indian corn can be prepared in very many forms as foods for human beings, and when served in a properly balanced ration all forms are wholesome and nutritious.

A rye head

Is rye ever used for human food? This is a question which only an American would ask. In Germany and Russia, and in other parts of Europe, rye is used very extensively for human food. In many places rye bread is much more common than wheat bread. Rye is nourishing and wholesome, and may be

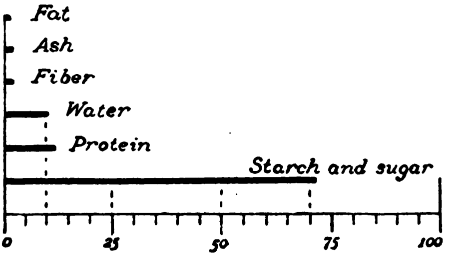
used to advantage alternately with white bread. Usually rye is cheaper than wheat, and for that reason there is generally some economy in its use for bread.

How does the composition of rye differ from that of wheat and corn? Rye has about the same percentage of protein as wheat, but a much smaller content of fat or oil than corn.

AVERAGE COMPOSITION OF RYE

	GRAMS
Weight of 100 kernels of rye	2.5
	PER CENT
Moisture	10.50
Protein	12.00
Fiber (indigestible)	2.35
Fat (oil)	1.50
Starch and sugar	71.75
Ash (mineral substances)	1.90

Sience rye contains less gluten than wheat, though more than Indian corn, rye bread usually has less elasticity than white bread, but is more elastic than corn bread. In making bread it is advisable to mix a little wheat flour with the rye so as to form a more elastic and more porous loaf. Rye is not grown extensively in the United



Average composition of rye

States. The average area devoted to rye is two million acres, while the average area devoted to wheat is more than forty million acres, and to corn, more than one hundred million acres.

Barley head

Is barley used as a food for human beings? Barley is another cereal that is used to some extent as food for human beings. But its use for this purpose is comparatively small. On the other hand, it is grown somewhat extensively in the United States for cattle food and for making beer.

When sprouted, barley is called *malt*, and then the barley grain or malt, above all other cereals, has the property of converting the starch it contains into a kind of sugar, or maltose, resembling cane sugar but, in many particulars, distinctly different from it. Malt makes a good food for human beings, and is used by many, especially those whose digestive organs are not in good condition. Many persons who have diseased stomachs are unable to digest starchy substances, but they can very readily take care of starch which is already partly digested. Very little barley is used directly as food in

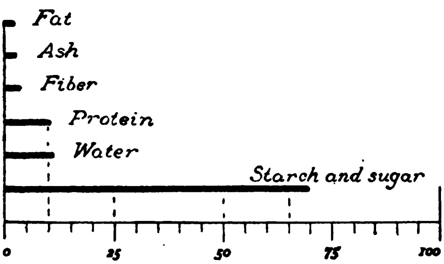
this country. It is served chiefly in soups and prepared, finely ground, for admixture with infants' foods.

What is the average composition of barley? Barley very closely resembles the other cereals in its composition, but its protein matter differs in character from that of the others.

AVERAGE COMPOSITION OF BARLEY

	GRAMS
Weight of 100 grains of barley	4.5
	PER CENT
Moisture	11.00
Protein	10.85
Fiber (indigestible)	3.85
Fat (oil)	2.25
Starch and sugar	69.55
Ash (mineral substances)	2.50

If we compare these figures with those for the composition of the other cereals it is seen that the amount of protein in barley is greater than that in Indian corn and less than that in wheat. It contains more fat, or oil, than wheat or rye, but less than Indian corn. It also has a larger content of mineral substances (ash) than wheat. Barley flour has very slight glutinous properties, and



Average composition of barley

hence it makes a bread more nearly resembling corn bread than wheat bread.

Carolina rice

What is the value of rice as a food? Next to wheat and Indian corn, rice is the most valuable food product among the cereals. It is used extensively by the oriental or eastern nations, especially in Japan and China. Rice is not widely cultivated in this country, the average area in rice in the United States being less than a million acres.

Rice, unlike other cereals, is usually grown under water. After the rice is planted and has begun to grow, water is turned on the fields and kept there until near harvest time. Other cereals would be killed by such treatment. A few varieties of rice grow in dry soil like other cereals, but they are not so highly regarded for food purposes. Rice, therefore, is grown to best advantage in lowlands which can be easily flooded, or in regions where abundant water is available for irrigation purposes.

How does rice differ from the other cereals? Rice differs from the other cereals chiefly in its high content of starch and its low content of protein. In its food value rice resembles the potato more closely than it does wheat.

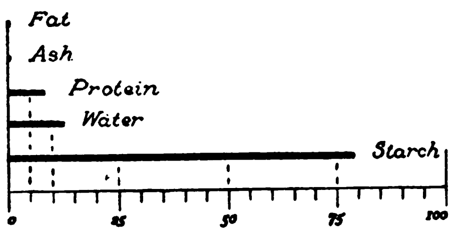
THE AVERAGE COMPOSITION OF RICE

	GRAMS
Weight of 100 grains of polished rice	2.25
	PER CENT
Moisture	12.30
Protein	8.00
Fat (oil)	0.30
Starch	79.00
Ash (mineral substances)	0.40

These figures show that rice has a low protein content, a low fat content, and a low mineral content. It is essentially a starch food.

How is rice prepared for eating? Rice is a cereal which is usually prepared for eating without being previously ground. There is such a thing as rice flour, but it is not widely used for food. The grains of rice, which resemble wheat grains in form, are cooked whole.

It has been a very common practice to submit the rice grains to a process of rubbing, by means of which the external coating, the rice bran, is removed without crushing the grain. Then, in order to make the grain still smoother and more shining in appearance, it has been customary to coat it with finely powdered talcum, using a



Average composition of rice

little sugar or glucose to make it stick. These practices are wrong because the consumer is deceived by the appearance of the grain, and especially because of the injurious effect of such rice on the consumer's health. It has been found that people who live almost exclusively on rice treated in this way develop a disease of the digestive organs in some respects resembling anæmia (poor blood). This disease, known as *beri-beri*, often proves fatal. But it has been found that when unpolished rice is eaten, beri-beri never occurs. Also, if the rice bran that is rubbed off in polishing is given to those who have the disease, they recover.

A bunch of oats

It is difficult to get unpolished rice in the United States. It is not so white nor so good to look at as the polished, but it is far more palatable, more nutritious, and more healthful.

Are oats used as food for human beings? In Scotland particularly, and in the United States, oats are largely used as food for human beings. When the oats, after the removal of the chaff, are crushed or ground, the product is called oatmeal, and oatmeal is much used for so-called breakfast foods; that is, for making the porridge or mush to be eaten with milk or cream, preferably at the morning meal. Oat products prepared in this way are to be had in all the markets of the United States and are used extensively. The oat has more gluten than Indian corn, but not nearly so much as wheat.

In the United States oats are used principally for feeding horses. The acreage planted in oats is very large, amounting to almost thirty-five million acres every year.

What is the food value of oats? One hundred grains of oats with the chaff on, this being the condition in which oats are always sold, weigh about three grams.

THE AVERAGE COMPOSITION OF OATS (unhulled)

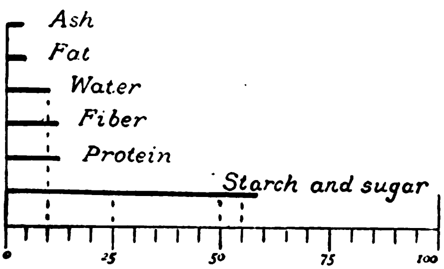
	PER CENT
Moisture	10.06
Protein	12.15
Fiber (indigestible)	12.07
Fat (oil)	4.33
Starch and sugar	57.93
Ash (mineral substances)	3.46

When oats are used as food for human beings the chaff or outer hull has been removed.

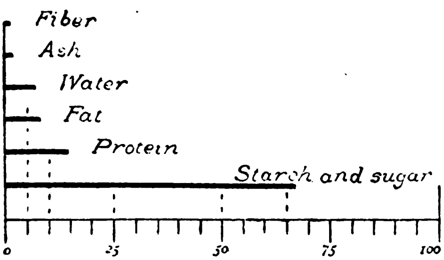
THE AVERAGE COMPOSITION OF OATS (hulled)

	PER CENT
Moisture	7.00
Protein	14.38
Fiber (indigestible)	1.38
Fat (oil)	6.00
Starch and sugar	69.10
Ash (mineral substances)	2.14

If you compare the composition of the hulled oats with the composition of the unhulled oats you will see that the removal of the chaff has increased very largely the percentage of fat and of protein, while it has diminished to a large extent the quantity of indigestible fiber. This is highly important from the point of view of food for human beings. While horses and cattle can eat unhulled oats, because they are able to digest the chaff, it would be difficult for the human stomach to utilize the unhulled product.



Average composition of unhulled oats



Average composition of hulled oats

It is also evident that the hulled oats differ from other cereals we have studied in the larger amount of protein they contain, and especially in the amount of fat. Hulled oats to a certain extent approach the character of nuts in the quantity of fat or oil they contain, though the quantity is much smaller than that in nuts.

Oatmeal is regarded as a wholesome, nourishing food. It is especially valuable for those who are engaged in hard work, as the oil in the oats furnishes a large amount of heat and energy. The large quantity of protein which is provided takes the place of the protein tissues which have been used up during hard labor. It also furnishes heat and energy. Hulled oats can therefore be recommended as a very important human food product. In the list of cereals used for breakfast foods there are many oat products.

XVIII. The Preparation of Foods

What is bread? Bread in its simplest form is a term applied to a cereal, ground whole or bolted, which has been mixed with water or milk in such a way as to form a paste or dough, usually leavened with yeast or baking powder, and then molded or rolled into any convenient form and baked on a stone or in an oven until the crust is brown. The term "bread," when used without any qualification in the United States, means bread made of wheat. The term "loaf" applied to bread means a portion of the dough formed as described above, molded into some convenient shape, and baked.

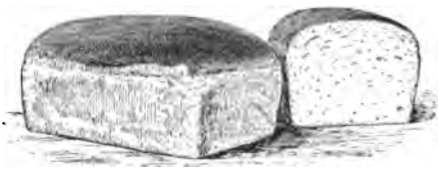
The seed of the cotton plant yields a large amount of yellow oil

What is shortening? The term "shortening" is applied to a fat or oil which is mixed with flour when a bread dough is made, for the purpose of making the bread more brittle and more easily broken after

baking. In addition to this the outside of the loaf or the inside of the pan is often greased with a fat or oil, so that after the bread is baked it will not stick to the pan. Nearly all bread has a little shortening added to it.

One of the most common kinds of shortening in general use is lard. Probably more lard is used for shortening than any other kind of fat. Butter also makes an excellent shortening material, and is used particularly in the making of cakes. Vegetable oils are used to a large extent for the same purpose, especially cottonseed oil and olive oil.

Wheat bread is an almost universal article of food at all tables. There is scarcely a meal served in the United States at which bread of some description is not eaten.



Wheat bread

What other cereals besides wheat are used for bread? All the cereals can be used for bread making. Indian corn is used extensively for that purpose, especially in the United States. Most of the bread made from Indian corn is eaten hot. There is also a bread made of corn meal called "pone." The corn pone was a staple article of diet among the early settlers

in our country. It is a wholesome and excellent kind of bread and deserves extensive use, but at present it is rarely made except in the homes of those who live near the frontier or in the South.

Rye is used extensively for bread making in foreign countries, but not to a great extent in the United States. In many parts of Europe, especially in Germany and Russia, rye is more commonly used for bread than wheat. Rye flour does not make so white a bread as wheat flour, but it makes a palatable and nutritious article which can be used now and then in place of white bread. Barley, rice, and oats are not used to any extent for bread making in the United States.

What are griddle cakes? Griddle or hot cakes are a variety of bread made from a batter much softer than that used for making bread.

A modern kitchen. Making bread in the home

A maple orchard in sugar-making time

They are baked quickly on a very hot, smooth surface. As soon as one side of the cake is brown it is turned and baked on the other side. It is customary to make the cakes out of buckwheat flour or corn meal, although white wheat flour makes a very good cake, more tough and elastic than that made from the other cereals.

The griddle cake is pretty regularly served in the United States at breakfast. It is eaten usually with sirup, made either from the sap of the maple tree, or from sugar cane or sorghum. Manufactured sirups which are made largely of glucose are common in commerce. Maple sirup is made in large quantities in New England, New York, and Ohio. It has been very extensively adulterated, and even now much

larger quantities of so-called maple sirup are sold than are made. It is a common practice among manufacturers to mix a little maple sirup with a large quantity of some other kind of sirup so as to give the entire mixture a maple flavor. Before the Food and Drugs Act became a law these mixtures were sold as pure maple sirup. Molasses, which is the sirup obtained from crystallized sugar in the process of manufacture, is also highly prized for eating with hot cakes.

Many food experts object to the use of hot cakes for food, claiming that in this condition the material is not so digestible as when made into bread. One of the principal objections to hot cakes is that they taste so good we eat too many of them.

Another form in which bread is used is known as cake. By the term "cake" is meant some cereal product to which considerable quantities of sugar, egg, and butter have been added, and usually some flavoring substances. There are many varieties of cake, with which most of you are already quite familiar.

Is the use of cake advisable from the health point of view? When cake is made out of wholesome materials — good flour, good butter, and good eggs — its wholesomeness is assured. Unfortunately, cake is usually not a part of the

dinner itself, but is served after the dinner as dessert. By the time dessert appears the ordinary person usually will have eaten all that he should eat. The appetizing character of cake, its appeal to the sense of taste, and, when well made, its general excellent qualities make it extremely tempting. We are therefore inclined to put into our stomachs large quantities of this very nourishing material after they have been given all the nourishment they need. In this way cake becomes a menace to health, not because of its own composition but because of the circumstances under which it is eaten.

Cake contains many nourishing materials. In addition to the flour, the egg content especially is one of the high-grade nourishing ingredients in cake. The butter and the sugar are well suited to the development of heat and energy. Therefore, if people eat much cake, they should take liberal exercise or work hard at manual labor. A person of quiet habits who takes little exercise and does not work hard would better let cake alone.

Is cake good for growing children? No, cake is not good for children. While it is nourishing and valuable as a food, it is an unbalanced ration for the growing child. In cake the heat-forming and energy-forming elements are

far more abundant than they should be in a well-balanced ration for growing children. Unfortunately, cake is one of the things the child is taught to desire more than most others, and when the taste for it is once formed it is difficult to overcome the temptation to eat it. It is far better to prevent the child from forming a habit than to try to control it when once formed.

XIX. Vegetables and Fruits

What are vegetables? In its widest significance the term "vegetables" includes all the products of plant growth. So "vegetable," in its broadest sense, is a term used to distinguish plant products from animal products. Both vegetables and animals, however, are living organisms, and there is probably no sharp line of distinction to be drawn between them. The vegetable product sometimes apparently merges into the animal product, or the animal into the vegetable. But we have, on the whole, a very distinct impression of the difference between a vegetable and an animal. A growing vegetable is nearly always fixed in its place. That is, it cannot move itself from place to place. It cannot go out and seek its food; its food must be brought to it. This mode of life is so different from that of the animal that we learn to distinguish between the two in our earliest years of observation. The child of very tender years will be able to distinguish between the mouse that runs over the floor and the plant that grows in a pot or in the yard.

In a food sense the term vegetable is applied to a certain kind of food produced generally in the garden, the composition of which is

characterized by a large percentage of water. The vegetables which have the largest percentage of water are called *succulent*, meaning full of juice. Among these are the turnip, the raddish, the carrot, the beet, cabbage, and spinach. Other vegetables, substances with less water though still holding a considerable quantity, are the white potato and the sweet potato. Thus we make a marked distinction between the vegetable on the one hand and the cereal on the other, though they both belong to the vegetable kingdom. In like manner we distinguish between the vegetable and the fruit.

What is fruit? The term "fruit" as regards food is applied principally to the products of certain trees and small shrubs or bushes and vines. The principal kinds used as food are apples, oranges, grape fruit, lemons, peaches, pears, and

Growing vegetables at home. A thrifty, well-planned garden

cherries among the larger fruits that grow on trees, and blackberries, strawberries, raspberries, grapes, blueberries, and currants among the

Children gathering and eating apples

smaller fruits that grow on bushes and vines. The distinguishing characteristics of fruits are, first of all, their *acidity* (containing acid) and their sweetness. The sugars and acids in fruits seem to vie with each other as to which shall win the upper hand. Sometimes the sugar is in excess, as in the very sweet apple, and sometimes the acids are in excess, as in the cranberry. In general the best fruits, judged from their taste alone, are those in which a balance is maintained between acidity and sweetness.

Fruits are not only pleasant to the taste but extremely valuable in relation to the general health. When it is possible to secure them, fruits should be eaten every day, not only to improve the meal but more especially as a safeguard to health. Nevertheless fruits are quite unsuitable for infants, and very young children should eat them sparingly. The child of five years and over may begin to eat fruits in greater abundance.

Should fruits be eaten raw or cooked? As a general rule fruits are best eaten raw. There are of course certain dangers connected with eating raw fruits which must not be forgotten. Raw fruits may be infected with insects or with so-called germs that are dangerous. These dangers can be removed by careful cooking. Many fruits, also, are difficult to chew, as for instance certain hard kinds of apples. Cooking improves them in this respect, making them more edible, or eatable, and more easily digested.

No hard-and-fast line, however, can be drawn. Perhaps it is best to say that fruits should not always be eaten raw, nor should they always be eaten cooked. A judicious admixture of the raw and the cooked fruit is advisable. Some fruits are never cooked, as, for instance, citrus products (orange, lemon, etc.).

The food value of fruits lies chiefly in the

sugar they contain. There are also valuable mineral ingredients in fruits which minister to the mineral needs of the body. All fruits contain a little protein, but as a rule, except in the case of olives, very little oil or fat.

How much sugar do fruits contain? The quantity of sugar in fruits varies with the nature of the fruit and the degree of ripeness. In ripe fruits the quantity of sugar varies from three or four per cent to as high as fifteen or twenty per cent. Very ripe grapes contain a high percentage of sugar. The small fruits, such as berries, contain the lower percentage, while apples, peaches, and pears have a medium content of sugar, varying usually from six to twelve per cent.

What kinds of acids exist in fruits? Fruits are characterized by the presence of different kinds of acids. The dominant acids in fruits are as follows: *malic* acid, which gets its name from *malum*, the Latin word for apple, and which exists in apples, pears, peaches, plums, cherries, and many other fruits; *citric* acid, which exists as the principal acid in the citrus fruits, oranges, lemons, and grapefruit, and is so called from the family name of these fruits; and *tartaric* acid, so called from the common word "tartar," a term applied to that compound of the acid with potash as it exists in grapes. Tartaric

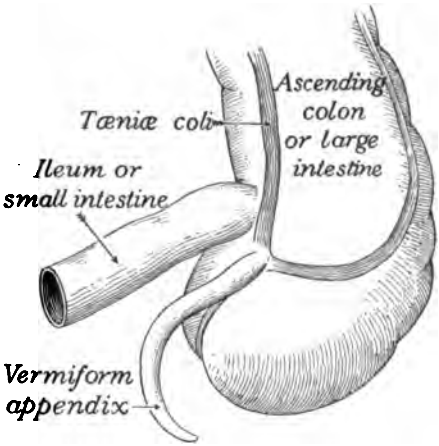
acid is found particularly in grapes of all kinds.

Traces of other acids are present in many of the fruit products, and it must not be inferred that only one kind of acid exists in any one fruit. Apples, and other fruits of the same class, may have traces of other acids besides malic. This is also true of oranges and lemons as far as citric acid is concerned, and of grapes as regards tartaric acid. The acids in fruits are always combined with a base, such as soda, potash, or lime, mostly potash.

Are the small seeds of fruits injurious? A great many of the fruits, such as berries and grapes, have very small seeds. In the case of berries, such as strawberries and blackberries, to try to take the seeds out would be a hopeless task. They may be removed by cooking the fruit and then straining the pulp through a fine sieve, but they cannot be removed with any success when one is eating the fruit raw. There are some varieties of grapes in which the seeds are few in number. These seeds are also larger than berry seeds, and may be the more readily removed. By eating one grape at a time the pulp may be separated from the seeds in the mouth and the seeds rejected. This is not considered good table manners, though it may be advantageous otherwise.

Some persons fear to eat small fruits, and

especially to give them to children, because of the presence of these seeds. It is maintained, perhaps with some reason, that the seeds may lodge in the appendix and cause that very common and much dreaded disease, *appendicitis*. But on the whole, these fears may be regarded as entirely groundless. While the seeds of fruits may possibly have been found in the appendix in some cases where it has been removed, they can hardly be regarded as the primary cause of the trouble.



The appendix

In general we may say that the seeds of small fruits will be excreted from the body without doing any harm. Larger seeds are objectionable, such as those of the apple, but these are not usually swallowed.

While it cannot be said that the swallowing of the seeds is *absolutely* harmless, yet the chance of harm is so remote that we should not for that reason refuse to eat these fruits. In the same

way, play might be regarded as dangerous. Boys and girls are often hurt, sometimes seriously, sometimes fatally, at play. But that is no reason for forbidding children to play. The most wholesome of our foods are sometimes injurious, either because of an over-sensibility of our system to their effects or because of our eating too much at one time. And yet no one would think of excluding such foods from our tables because we are sometimes injured by them. It is nature's way. There is nothing that is perfectly safe and to some degree we must take our chances. At the same time, watchfulness and careful supervision are necessary to avoid taking unnecessary chances.

XX. Animal Foods: Flesh, Fish, Fowl, Milk, and Eggs

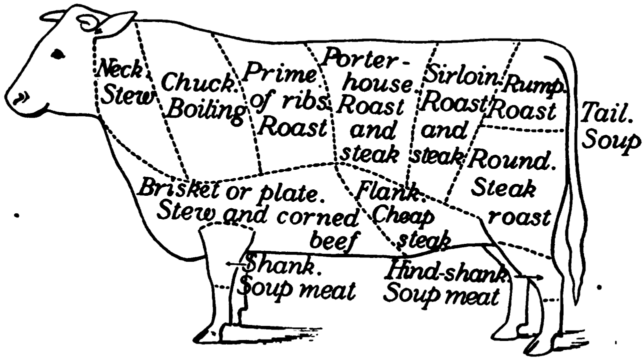
Is it proper to eat meat? Meat is the flesh of animals, or rather, the edible portions of animals. Milk and eggs are also to be regarded as animal foods. Thus at the very outset we see that milk, the natural food of the infant, is an animal food and one of the necessary foods for growing children.

Even grown people, who no longer need to take their food in the form of milk, may yet take a considerable quantity of milk with advantage. Especially is milk one of the indispensable foods for invalids. There are many kinds of illness in which the patient cannot eat ordinary foods. But he is in a very hopeless state indeed who is no longer able to get some nourishment from milk.

The structure of the teeth and the digestive organs of man lead to a belief that throughout life he is, to a considerable extent, adapted by nature to be a consumer of animal foods. Thus from every point of view meat in proper quantities and at proper times may be considered a normal though not indispensable food for man.

At what age should we begin to eat meat? In this connection meat should be defined as the

edible portions of the bodies of animals, excluding milk and eggs. The term meat, therefore,



Location of the various cuts of beef

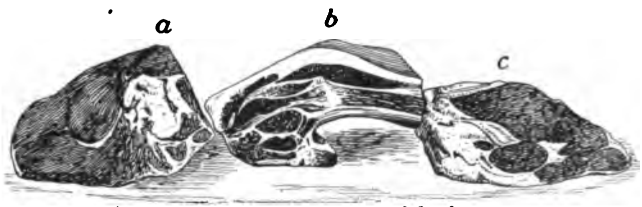
includes not only the lean and the fat meats but also the nerves and the tendons, the brain, and the vital organs of the animal that are suitable for food. Nearly all parts of the body of the meat-producing animal are edible. Blood is used extensively as food, especially in Europe in blood sausage. The skin, the bones, the intestines, and the lungs, however, are rarely eaten. The bones are not generally used as food, simply because of man's inability to chew them. Finely ground bone is a very good food, though rich in phosphorus.

There are many different opinions concerning the age at which children should begin to eat meat, in the sense of that term as we have defined it. To give children a little meat while

they are still infants is a common practice, and it is quite common to begin feeding children of eighteen months and over small quantities of meat. This I do not believe a wise course. The digestive system of the child, especially the very young child, is not well adapted to the digestion of meat. While there is not much danger in giving a two- to five-year-old child a small bit of meat once in a while, he can get along very well without it.

On the whole I should say that children under the age of five years should eat little meat of any kind. After that, small quantities of the meat of healthy, recently killed animals, especially fowls, may be given. Cured meats, and meats that have been kept in cold storage, should not be given to children under ten years of age, and very little after that age.

Meats are digested partly in the stomach. This is not true of starches, fats, and oils,



Some common cuts of beef
a, round roast; *b*, rib roast; *c*, loin roast

whether vegetable or animal. These foods are digested largely in the small intestines. Since

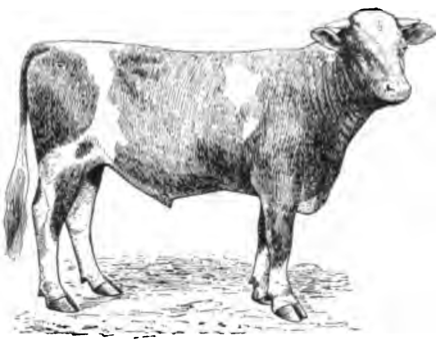
the stomach of the child is adapted first of all to the digestion of milk, and since the composition of milk is entirely different from that of meat, some of the best writers on the diet of children say most emphatically that meat should not be given to young children. I share their opinion.

When the child begins growing vigorously, as he does between the ages of eight and fifteen years, meat is especially desirable. After the growing age is past we can get along with less meat, and when we get old we should, like little children, eat it very sparingly. When we become very old, we shall find, as is true of little children, that milk is again the best food for us.

What are the meats most suitable for food? In general it may be said that the meat of all animals is edible, but in many cases, by prejudice or religious tenet or by custom, we are led to reject the meats of certain animals and to eat the meats of certain others. The common meat-producing animals are cattle, hogs, sheep, and goats. Among the feathered tribes, chickens, turkeys, pigeons, partridges, ducks, and geese, both domesticated and wild, are largely used for food. Among the finny tribes there are hundreds of edible varieties; in fact, there are few fish that are not edible. We have, therefore, a wide range of choice, and we are

generally disposed to divide our animal diet into the three classes named — flesh, fish, and fowl — meaning by flesh the edible portions of the animals ordinarily eaten. We also divide meat into two classes, red and white, speaking of meat largely as the muscular or nitrogenous portions of the animal. The animal fats, while they as well as the muscular portion of the animal should be included under the term meat, are not usually so considered. This is not a correct view, however, because no matter how lean the meat is it always contains some fat, and a little fat adds much to the flavor and character of meat.

Some animals such as the horse are edible but are not used widely for meat. Moses, in the books in which he advises the proper diet for his people, permitted the eating of all animals that have a cloven foot and chew the cud. This would include the cow, the sheep, and the goat. According to the law of Moses pork was forbidden, because



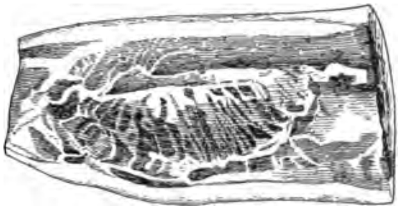
A steer ready for market

although the pig has the cloven foot he does not chew the cud. For the same reason the use of horse meat would be forbidden, since the horse neither chews the cud nor has a cloven foot. Experience has shown, however, that horse meat is both edible and palatable, and in some countries, as in parts of Europe, it is eaten in considerable quantities. Unfortunately for the reputation of the meat, the horse is not often used as food until the animal is too old and bony to be good for any other purpose. Naturally the meat of such an animal cannot be very inviting. Horse meat is not much eaten in the United States, although a great deal of horse flesh has been shipped out of the country for consumption in Europe.

Horse flesh is sometimes used as meat

The hog, however, has come into general use as food, and by many persons pork is relished more than any other kind of meat. The flesh

of the hog is especially suitable for curing, far more so than that of any other meat-producing animal. For that reason comparatively little hog meat is eaten fresh. The smoked and cured hams, shoulders, and bacon of commerce illustrate the truth of this statement.



A side of bacon

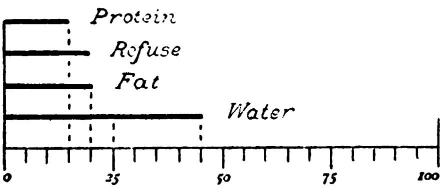
On the contrary, most of the meat of beef cattle is eaten fresh, much of it being kept in a fresh state in cold storage. Considerable quantities of beef, however, are pickled and preserved in brine, and this product is known as corned beef. The flesh of sheep is usually eaten fresh also. Mutton does not readily lend itself to preservation, except by cold storage.

Fowls are best for food when fresh, although immense numbers of fowls of all kinds are kept in cold storage, some of them entirely too long so far as their being palatable and wholesome is concerned.

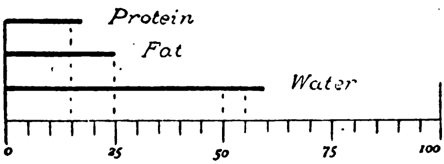
Yet it is quite true that keeping the flesh of poultry and of game for a certain length of time at a low temperature improves its character as regards flavor and taste. And it is well known that beef, which is one of the chief animal

foods, is quite materially improved by being hung for from three to six weeks at a temperature near the freezing point before it is offered for sale in the markets.

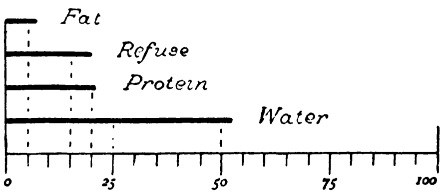
But to keep perishable foods in cold storage for an indefinite time, even when frozen, allows them to deteriorate in quality and so makes them less palatable. In my opinion it also renders the foods less wholesome. Cold storage, therefore, should be practiced with moderation, and rarely should articles of food be left in cold storage longer than six or nine months before consumption.



Ribs of beef. Proportions of fat and lean



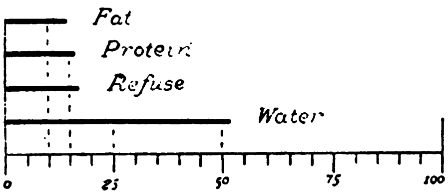
Beef tenderloin. Proportions of fat and lean



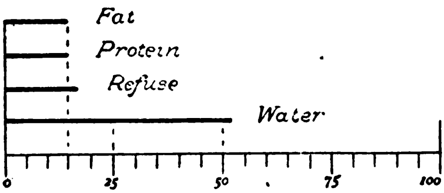
Beef round. Proportions of fat and lean

What is the composition of meat? Not only does the meat of different species of animals vary in its composition, but also the meat of different animals of the

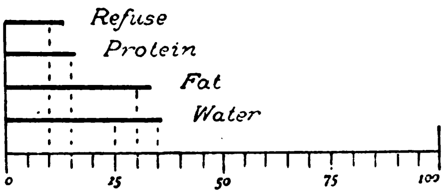
same breed. All meats, however, contain the same principal food elements. For that reason it will be necessary to give only in a general way the composition of the flesh of edible animals. The edible portions of all animals consist almost entirely of fat or oil and protein. The muscles, the tendons, the nerves, and the brain are made up largely of protein. The bones, which are inedible, also contain a large amount of protein. This is sometimes extracted from the bones, forming the gelatin of commerce. But compared with red meat, gelatin is not a nutritious food. The bones consist largely of a mineral substance,—phosphate of lime,—but they also contain much protein.



Leg of lamb. Proportions of fat and lean

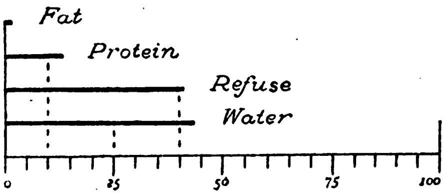


Leg of mutton. Proportions of fat and lean

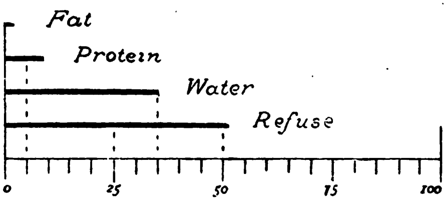


Smoked ham. Proportions of fat and lean

The muscular tissues of animals, as we have learned, are almost pure protein — that is, they consist almost exclusively of nitrogenous substances. The proportion of nitrogen to fat in meat varies greatly, according to whether the animal is thin or fat. It varies also according to the part of the animal eaten. The sides of the hog from which bacon is made are composed mostly of fat, with only an occasional streak of muscular matter passing through the fat. The muscular tissues contain more or less fat according to the nature of the animal and the way it is raised. As a rule, probably half of the edible portion of animals is fat. This of course includes the fat which is stored in various parts of the tissues. Some portions of pork are nearly all fat.



Chicken. Proportions of fat and lean



Fish. Proportions of fat and lean

It must not be forgotten that we do not eat all the fat of an animal in the form in which it is originally found. From the fat hog, besides the fat we eat with the meat

we get a great deal of lard. From fat beef and mutton we get tallow, which is often not used for food at all but for soap making and other purposes.

The edible portions of game and of most varieties of poultry are more lean than fat, while on the other hand both pork and beef have more fat than lean. In fish, also, the amount of nitrogen or lean meat generally exceeds the amount of fat. However, some kinds of fish, such as menhaden, are used almost exclusively for the oil they yield, and not as food.

PROPORTIONS OF FAT AND LEAN IN 100 PARTS OF MEAT, POULTRY, AND FISH

FOODS	WATER	REFUSE	PROTEIN (LEAN)	FAT
Ribs of beef....	45	19	15	20
Beef tenderloin.	59	none	17	25
Round of beef..	52	19.5	20.5	7
Lamb (leg).....	52	17	16	14
Mutton (leg)...	52	17	15	15
Ham (smoked)	36	13	16	33
Chicken........	43	41	13	2
Fish...........	35	51	9	2

The above data refer to the articles as purchased and not as prepared for the table. They do not include the quantity of mineral matter (ash) or other elements which may be present in small quantities.

XXI. Preserving Foods

What is the purpose of preserving foods? Nature produces foods in greatest abundance at certain periods of the year, as during the summer. In temperate regions at other seasons, as during the winter, under natural conditions no vegetable foods are produced. Meats, fish, and poultry are available at nearly all seasons of the year, but are more abundant at certain times than at others. It follows from this uneven distribution of production that if we had no method of preserving foods we might have too great a supply of food at one time and far too little at another. Hence, for reasons of economy and nutrition, it is necessary to preserve foods.

Do all foods need preserving? There are some foods which may be safely kept a long time, since their natural qualities make them resistant to decay. Good examples of these foods are the ripened kernels of wheat, corn, oats, rye, and other cereals. When kept dry and free from insect pests, these foods may be stored for a year or longer without becoming less palatable or less wholesome. In fact, these foods to a certain extent improve with age. They are better for milling and for general handling after they have been kept a few months than they are

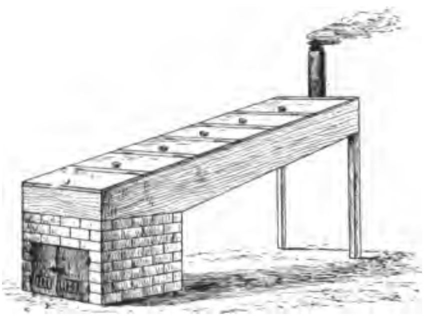
immediately after being harvested. This is because they dry out and thus become hard and more resistant to decay.

Succulent vegetables may also be kept for a considerable length of time without loss of quality. For instance, potatoes, turnips, beets, radishes, and cabbages, and fruits of many kinds, such as apples, pears, and oranges, may be kept for many months if put in a cool, dry place and protected from freezing. But vegetables do not retain their good qualities nearly so well as do the cereals, and usually fruits are better if not kept too long. Certain fruits, such as strawberries, raspberries, and blackberries, keep only a few days. Peaches and apricots keep for a comparatively short time. Many foods which are eaten in an immature state, such as green corn, will keep only a few hours without deteriorating in quality. Green corn, like green peas, deteriorates very rapidly in quality after it has been plucked from the stalk. If you wish to eat green corn or green peas the best plan is to go into the garden or field, gather the vegetables, and cook them immediately. In this way you get these delicious foods at their maximum of sweetness and tenderness.

Flesh food, whether of domesticated animals, poultry, wild game, or fish, deteriorates rapidly, especially in warm weather. It may be said

to begin to deteriorate from the moment the animal is slaughtered, although it may be many hours or even days before this deterioration becomes evident in the taste and odor of the article.

What are the methods of preserving perishable foods? There are several well-known methods of preserving perishable foods, some of which are good and others highly injurious. Inasmuch as it is the large amount of water in foods that promotes deterioration, one of the oldest and best methods of preserving these products is by drying. Fruits may be spread in the warm sun and in a few days dried sufficiently to keep a long time. In localities where the air is very pure and dry, as in Arizona and New Mexico, fresh beef hung up on a pole is dried so quickly that it will keep its qualities for months. This product is called "jerked beef."



A fruit dryer

Dried beef, well-known in commerce, is produced by exposing the meat, after it is properly salted, to artificial heat or to the natural drying process of the air.

Usually, artificial heat is used in the drying of perishable fruits; that is, the fruits are sub-

Drying raisins in trays in the open air

jected to hot air at a temperature that will not char or bake them, but yet dry them out rapidly. The air is warmed first by a furnace built for that purpose. This air is then conducted over the fruit to be dried. Hot air absorbs a great deal more moisture than cold air.

In this country the principal foods preserved by drying are the fruits. Annually vast quantities of peaches, apples, pears, apricots, and other fruits are dried. Grapes are also dried, the resulting product being known as raisins. One of the greatest centers of the dried-fruit industry is in California. There the long, hot days and periods of dry weather make it possible to dry almost all kinds of fruit by means of the

sunshine alone. In rainy countries this drying process is difficult because of the rainstorms

Women preserving fruit by canning

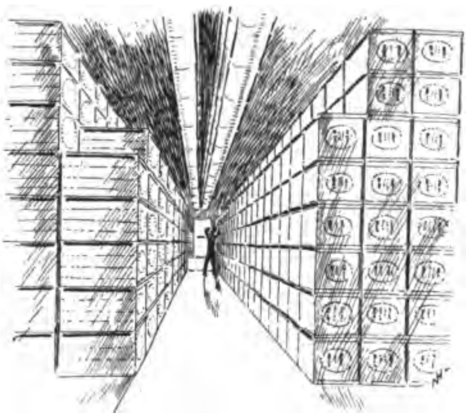
which come often and with little warning.

Vegetables of various kinds, too, are dried, but this industry has not reached any magnitude because of the difficulty of restoring the dried vegetable to its natural condition when it is prepared for eating. Potatoes, sweet corn, and various succulent vegetables have been dried successfully, but to no such extent as the fruits.

What is another good method of preserving perishable foods? More than a hundred years ago a French chemist by the name of Appert discovered the fact that if perishable foods are heated and kept at the temperature of boiling water for a certain length of time, and then

inclosed in air-tight packages, they will keep indefinitely. This was the beginning of what is known as the canning industry. Canned foods are perishable foods, such as vegetables, fruits, meats, milk, and other products, which have been heated to the temperature of boiling water for varying lengths of time and then placed in containers from which the air is excluded. The industry is one of great magnitude. The articles canned in this country are chiefly fruits, tomatoes, green corn, peas, beans, meats, and milk, although almost every kind of food which is eaten may be preserved in this way.

What food products are commonly kept in cold-storage warehouses? This is a most important question and one concerning which every one should have exact information. The common foods kept in cold-storage warehouses are, first, meats of all kinds, poultry, fish, and game. In addition to these articles



Interior of a cold-storage warehouse

the product most commonly placed in cold storage is eggs. Eggs, in millions of dozens, are kept in storage from the time of abundant production, in March, April, and May, until times of need, in December, January, and February. Fruits of all kinds, particularly apples, are placed in cold storage in great quantities.

At what temperatures are these foods kept? Poultry and fish are kept at a temperature much below the freezing point of water. The result is that the poultry and the fish become frozen solid and remain in that condition in the cold-storage warehouse until sent to market. Sometimes meat is also frozen, as, for instance, a great deal of the fresh meat shipped from Australia to Great Britain. But most beef is kept at a temperature just above the freezing point. Eggs are kept at a temperature at which they will just escape freezing, the nearer to the freezing point the better. Milk and cream also are kept at temperatures just above the freezing point. Thus by the judicious application of cold, great stores of all kinds of food are preserved in a reasonably good condition for future use.

Are there any dangers from the practice of cold storage? Like every other good thing, the practice of cold storage may be abused. Foods may be stored for the purpose of influencing

prices, and they may be kept so long they are neither palatable nor wholesome. Such foods

A modern poultry house and yard

endanger the health of the consumer. These are abuses which can be avoided by proper regulation or by an enlightened public sentiment.

How long should foods remain in cold storage? There is only one answer to this question—just as short a time as possible. There are certain kinds of foods which need to be kept in cold storage only long enough to secure proper transportation and sale at the point where the foods are consumed. Such foods as these are fish and poultry. The fishing season extends

over nearly the entire year, so it is possible to secure reasonably fresh fish at almost all seasons. Poultry can be produced at all seasons of the year, though naturally it is most abundant in the spring. Eggs and chickens are more abundant then than at any other time, but by the judicious distribution of hatching periods, which is made possible by modern methods of poultry keeping, young chickens may be produced at all seasons of the year. Poultry is therefore another food product which should be kept in cold storage only long enough to transport it and sell it. The abuse of cold storage lies chiefly in the practice of keeping these products—fish, poultry, and eggs—for too long a time in order to influence prices or for other reasons.


Churning butter

Butter is another product which is more abundant in the spring than at any other season. Hence large quantities of butter are put into cold storage in the spring to be sold during the following winter. There is no objection to this procedure, with either butter, eggs, or poultry, provided great care is taken to see that

they go into cold storage in the best condition. Most of the abuses have consisted in storing products that had already begun to decay. Of course articles in such a condition can never be improved. On the other hand, good products, placed in storage in the best condition, should be kept for limited periods only. I do not know of any food product which for any reason should be kept in cold storage more than eight or nine months. If kept longer the food may be injurious to the health and well-being of the consumer. One great need in regard to cold storage is that every food product kept in storage longer than the time necessary to transport and sell it should be so marked that the buyer may know what he is getting and how long it has been in storage.

In general, cold storage is a great blessing, and will become a still greater blessing if the abuses and dangers referred to are remedied.

Is there any other method of preserving foods? Yes, one of the most important methods of preserving foods has not yet been mentioned. It may be termed the "pickling method." This method is applied both to meats and to vegetables. We are all familiar with the ordinary pickles of the household, made chiefly from the cucumber. The ordinary vegetable pickle is usually preserved by means of salt, sugar, and

vinegar. In addition to these three articles many spices are used in pickling, largely because of the flavor or taste which they give to the product.

The principal ingredient used in the pickling of meats is salt. The great mercantile product known as "mess pork" is the flesh of swine preserved principally in brine, a strong salt solution, or in salt. In the preparation of pork, as of bacon or ham, the flesh of the freshly slaughtered hog is first treated with salt in such a way as to permeate as nearly as possible every part of it. When pickling thick pieces of meat, like hams, the salt is injected into the meat with a syringe, as well as applied externally.

After the salt has thoroughly permeated the meat it is put through another process, known as curing. The bacon and the hams and shoulders are hung in a room where smoke is produced usually by burning green wood, preferably hickory or oak. With the old-fashioned method of curing, many repeat the process once a month. But in the great packing houses the smoking is forced. There the hams and bacon are placed in closed chambers at a high temperature and large quantities of smoke forced into them, so that the smoking will occupy only a few hours. That is one reason why these products, when prepared in the packing houses,

never reach the grade of excellence found in products prepared in the old-fashioned way on a small scale. The home-cured ham or bacon, if properly prepared, is always superior to that produced on a large scale. Unfortunately, however, few farmers understand how to cure meats, so that often the home-cured ham is inferior to the packing-house product.

In order to preserve the red color of meats saltpeter is often used in small quantities at the time of salting. Saltpeter has the property of producing an artificial color in the muscular fibers which closely resembles the natural red color. Thus when ham or bacon is cut the muscular fibers are a bright red and resemble fresh meat. This process is to be condemned for two reasons: first, because the color is deceptive; and second, because chemicals of this kind, if used in any considerable quantity, have a distinctly harmful effect upon the kidneys. Nevertheless, the use of saltpeter in pickled meats is permitted by the federal officials and by the authorities of the various states and is practiced extensively.

After ham or bacon has been smoked it is covered, so that it may be free from the attacks of insects, and then is left hanging so as to keep dry. Smoked ham and bacon are highly appreciated as foods in all parts of the world.

Beef is also preserved in the same way as pork, although not a great deal of it is smoked. Generally beef is preserved in brine, and when so preserved it is called "corned beef." Common salt and saltpeter are the chief ingredients used in corning beef.

A tomato plant with fruit

One of the preserved vegetable foods in common use is known as catchup. Catchup is made usually of tomatoes to which vinegar, salt, spices, and sugar are added. These articles, however, are not used in quantities sufficient to prevent the tomatoes in the catchup from spoiling. Therefore when the catchup is made it must also be sterilized by heat.

To what is the color of catchup due? In catchup that is properly made the red color is due solely

to the tomatoes. For this reason ripe, red tomatoes are used. Whenever catchup is artificially colored, which at the present time is not often the case, you may be certain that the tomatoes used were not of the proper color or degree of ripeness. If green tomatoes have been used the catchup will not have the right color. Only red, ripe, perfect tomatoes should be used in the manufacture of catchup. In order to get the best color the catchup should be made quickly. This is possible in large factories which have every facility for the process, and for that reason the catchups made by large manufacturers have a more decided red color than those made at home. This is due to the fact that the long period of heating, which is necessary in the home manufacture of catchup, is likely to dim the color of the product.

What keeps catchup from spoiling? Catchup is kept from spoiling by being thoroughly sterilized by heat when it is made. If it is of the proper density, that is, if it has from twenty to thirty parts of solid matter per one hundred, and if it contains the proper quantity of sugar, spices, and vinegar, the catchup will keep for a considerable length of time after the bottle is first opened. In small families, however, very small catchup bottles should be used, while

larger families, or hotels and restaurants, may safely use larger bottles. Catchup should not be used after the bottle has been opened more than three or four days, unless it is kept in a refrigerator. In other words, a catchup bottle should be of such a size as to make certain the consumption of the contents within three or four days. Many catchups will keep much longer than three or four days, but the sooner the catchup is used after the bottle is opened, the better.

A bottle of catchup

What are some of the adulterations of catchup? Some cheap forms of catchup are made out of the cores and skins of tomatoes, or out of green and imperfect stock. But high-grade manufacturers never indulge in such practices. Pulp cheaper than that made from tomatoes is also used to adulterate catchup, as for instance the pulp made from pumpkins, and from the cores and skins of apples. All such admixtures as these are regarded as adulterations. Catchup is preserved sometimes by using benzoate of soda, but that practice is rapidly disappearing.

What is jelly? "Jelly" is the term applied to the substance derived from boiling a fruit juice to which a certain amount of sugar has been

added. This substance after cooling has the property of hardening to an elastic, gelatinous mass. Among the fruits used for making jellies are berries, apples, plums, grapes, and similar fruits. Since jelly is unusually attractive to the taste, it is not advisable that children should eat it to any extent until they are old enough to control their appetites.

The preservation of food products by the ways and means given constitutes an extensive industry and one of great value and importance to all people. In regard to the effect of preserved foods upon health I can only say this, that there is no treatment to which food can be subjected for the purpose of preserving it that does not to a certain extent injure it in quality and render it less palatable. In the strictest sense of the word, the preservation of foods, no matter what the way, is contrary to the best interests of palatability. However, though there may be a slight danger to health from the salt, the vinegar, and even from the spices used in the methods of preserving described, this danger is so small that it is not a sufficient justification for excluding these well-known products from our food lists.

XXII. Nuts as Food

What is the food value of nuts? Nuts are those food products found among the fruits or seeds of trees. They are composed chiefly of protein and fat, and therefore have a high food value. All nuts also contain a considerable quantity of sugar, but only a few, such as the chestnut, contain much starch.

Are nuts better for food when raw than when roasted? The answer to this question is both yes and no. Many of our common nuts are palatable in the raw state. Especially is this true of walnuts, hickory nuts, and pecans, all of which belong to the same general family. The flavor and character of nuts of this kind are not improved by heat. But there are other nuts which are much more palatable and aromatic after being roasted. Among these the most important are the peanut and the chestnut. Both of these nuts are greatly improved by roasting. In fact, the peanut is rarely, if ever, eaten raw. It then has a harsh, bitter taste quite different from and much less agreeable than that developed by roasting it. The chestnut is palatable and agreeable both in its raw and in its roasted state, but is considered much more digestible when roasted.

What are some of the principal varieties of nuts? It is not necessary to tell the boys or girls who live in the country much about the common kinds of nuts. You cannot go into the forest in the autumn without finding them. The nuts found most commonly in the forest

A white oak tree

are those that grow on oak trees. They are called acorns. Among the most majestic trees of our eastern forests is the oak. Oak trees live to a great age and in favorable localities grow to a great size. The acorn is a beautifully formed nut, growing out of its cap in the familiar way you all know. Acorns are gathered for food by squirrels and birds. Hogs are particularly fond of them. In the autumn many a farmer turns his hogs into his oak forest, where they fatten on the acorns.

Acorn fruit and leaf

Another nut found on forest trees is the beechnut. In shape it is triangular like a grain of

buckwheat. It does not grow so large as the acorn, but it is much more palatable, although it is rarely found in the markets. Only children who live near a beech forest really understand what excellent eating beechnuts are.

A third important nut of the forest is the hickory nut. Hickory nuts are justly esteemed as among the best and most palatable of all nuts. The pecan, which grows only in the southern part of our country, is one of our finest nuts. It is not found to any great extent north of Tennessee and North Carolina, but grows best south of these states, in Georgia, Alabama, Louisiana, Mississippi, South Carolina, and Florida. The pecan is now being cultivated in large orchards in various parts of these states. The cultivated varieties are large, with very thin shells and correspondingly large kernels. This nut is a great favorite with a large class of people.

Many other kinds of nuts grow wild, and among these one of the best is the hazelnut. The black walnut also, with which the American boy is acquainted, was a very common nut until our walnut forests began to disappear. The black walnut tree was always to be found on very fertile land, in this respect resembling the maple. In clearing the land for farms, the early settlers preferred the richest lands, and

so quite naturally the walnut and maple trees were the first to disappear. No longer are the farmer boy's hands stained with the walnut juice, once an almost universal condition during walnut-gathering time in October and November, after the frosts. From the outer covering of the walnut our grandfathers and grandmothers extracted a stain which they used in dyeing.


A walnut tree

The butternut is an elongated walnut with much the same taste and many of the properties of the walnut. The English walnut is a thin-shelled, cultivated walnut, which differs in many respects from the wild walnut of the American forests. All these nuts grow on trees, except the hazelnut, which grows on a shrub or bush.

What is the difference between the peanut and the nuts that grow on trees? The peanut is the fruit of an annual plant, and instead of growing above the ground as other nuts do, it grows underground. The flowers from which the peanuts develop grow on long, flexible stems above ground. These stems bend to the ground

and burrow under the surface, where the nuts form and ripen. The peanut grows best in the southern states of our country, being raised in great profusion in southern Virginia, North Carolina, and Tennessee.

A peanut plant

The peanut is used principally as a food for human beings. It is always roasted, a process which, we have already learned, improves its taste and aroma. The peanut is one of the important features at open-air meetings, picnics, and public gatherings of all kinds. The baseball game, the football game, the horse race, and the circus would hardly seem real if the noisy venders of peanuts and popcorn were not present to satisfy the popular demand for these products. Peanuts are a wholesome and nutritious food product, but are usually eaten in too large quantities and thus to a certain extent unbalance the ration. By this is meant that the quantity of protein and oil obtained in this manner exceeds the correct proportion of these food elements necessary for the best condition

of nourishment. Peanut butter is the roasted article, crushed.

What relations have nuts to health? When used in the proper quantity, nuts are a valuable addition to our food supply. Nuts may also be used to advantage because of their direct influence on health. In this respect nuts occupy much the same position as fruits, being not only food products but health-food products. Because of its oily nature the nut acts as a natural laxative, tending to correct constipation, a condition too prevalent among people of all ages and occupations. This fact, however, does not justify the fads of some food experts who recommend nuts as the sole diet of mankind. This is far from being a health measure. It is more than likely that it would be injurious to health to exclude from the diet all food products except nuts. It is unwise to conclude that because a certain food promotes health, that health is best secured by eating only that food.

A more widespread use of nuts as food, and perhaps a more limited use in a single day than is sometimes indulged in, is advisable for the best interests of health. For instance, it is better to eat a few peanuts once a day than to eat a large quantity one day and none at all for a week.

Are there any dangers in eating nuts? I have already pointed out that by eating nuts to excess you may take in more protein, and especially more oil, with your food than is advisable. In addition to this, you must be careful when eating raw nuts to avoid eating insects and their eggs. The nut is an ideal food for certain insects, and the mother insects understand this and that is why they bore through the shell and lay their eggs inside the nut. Certain wild nuts, especially the chestnut, are apt to be infected in this way. Roasting the nuts is a complete guarantee against the danger of taking the living eggs into the stomach. Still, many of us do not like to eat worms, even though they are well cooked.

Fortunately, most of the nuts we eat are easily inspected, and the worm is always honest enough to make itself known when the shell of the nut is removed. If the nut has been infected the results are always visible, and with a little attention it is easy to guard against danger from this source. Moreover, the danger is very slight, since it is not at all likely that any of the insects or the eggs found in nuts will continue to develop in the intestines. Yet such things do sometimes happen, especially in children. Various sorts of worms infect the alimentary canal of young persons. Some of them may be

harmless, but all are disagreeable and some, like the tapeworm, are positively dangerous. None of these insect pests are natural to the intestine. They are all introduced from without, usually in the form of eggs and generally with our food.

Hence cooking, while it may injure the taste of some foods, prevents insect infection, which is always more or less threatening to health. Therefore children eating nuts should carefully inspect them beforehand and reject all that show any evidence of insect ravages.

When should nuts be eaten? As a rule, nuts should be eaten at mealtime. As a matter of fact, however, a large proportion of the nuts that are eaten, especially by children, are taken between meals. When only a few are eaten this is not especially objectionable, but to eat large quantities of nuts between meals is not advisable, not because they are nuts but because it is not best to add fresh quantities of undigested foods to those which are partly digested.

XXIII. Beverages

What kind of beverages should the child use? Children should drink nothing but pure water or pure milk. All other beverages are unnecessary, habit-forming, and injurious.

What is pure drinking water? Pure drinking water is not exactly the same thing as pure water. Pure water is water that contains nothing besides water. It is very difficult to obtain. The ordinary distilled water used by druggists cannot be said to be entirely pure. Distilled water, moreover, is not the best drinking water for children. For them the ideal drinking water is the spring or well water that is entirely free from surface contamination. Such water contains in solution a certain quantity of those mineral substances which are present in the soil through which the water percolates or oozes, on its way down from the surface.

How much mineral matter is found in good drinking water? The quantity of mineral matter in water varies with the character of the rocks with which the water comes in contact as it percolates through the earth. Limestone is much more readily dissolved than sandstone, hence lime is usually the chief mineral found

in water. When spring water does not pass through limestone, other mineral substances are found in it, but usually not in large quantities. When small quantities of mineral matter are present the water is said to be "soft"; when large quantities of mineral, especially of magnesia and lime, are present, it is said to be "hard."

An old-time well-sweep

Which is more wholesome to drink, hard water or soft water? Usually a soft water that contains just the proper proportion of mineral matter is best for drinking. If the water is too hard it may contain more mineral substances than are necessary for good health.

Can hard water be softened? Hard water may be softened in two ways. In hard water there is often an excess of carbonic acid holding a certain quantity of minerals in solution. If the water is boiled the excess of carbonic acid is driven off and the minerals which were held

in solution by the excess of carbonic acid are precipitated or released. Thus by the simple process of boiling, some hard waters are rendered more or less soft. Teakettles used for boiling hard water become incrusted with the precipitated mineral. If hard water does not soften by boiling it can be softened to a considerable degree by adding washing soda or borax. The addition of ammonia to water will also tend to soften it. Water softened in this way must not be used for drinking.

What is the best location for a spring? We have no choice in the location of springs. Nature has decided that for us. But we may choose between springs, when more than one is available. In selecting a spring as a source for drinking water the locality from which the waters are believed to come should be carefully inspected. A spring on the side of an uninhabited hillside or mountain provides an ideal drinking water, cold and clear.

A hillside spring

But the water in a spring may really come

from a much greater distance than we suppose. So it is not always possible by inspecting the immediate neighborhood of a spring to determine the character of the soil through which the waters pass. For this reason we should call on the geologist, or notice the dip of the strata, or layers of rock, which will give some indication of the direction from which the water comes.

The only way we can be sure about the character of water is to have it carefully examined by the chemist and the bacteriologist. The chemist will tell what minerals the water contains, and the bacteriologist will tell us all about the bacteria or organisms which may be found in it. Spring water coming from uninfected localities will be almost sterile; that is, it will contain almost no living organisms. The smaller the number of organisms or bacteria a water contains, the better it is for drinking.

The wise general in an enemy country does not permit his soldiers to drink water until it has been analyzed. The waters may be naturally bad or may have been purposely poisoned. The Japanese army in Russia sent chemists and bacteriologists ahead of the troops to put up notices as to the waters that might be drunk and those that were to be avoided.

How much water should children drink? The body requires a greater quantity of water than

we can get indirectly as an element in the foods which we eat. So the human animal needs to take a good deal of water in addition to the food he eats. The amount needed varies with the character of his food, the temperature of the atmosphere in which he lives, and the amount of physical exercise he gets. The drier and saltier the food, the greater the quantity of water needed. The higher and drier the atmosphere, the greater the quantity of water needed; and the more vigorous the exercise, the greater the quantity of water needed. Thus water would be required to the greatest degree in the case of a person who ate very dry, salty food in hot weather, and who at the same time engaged in vigorous manual labor or violent exercise. It follows that we need the greatest quantity of water in summer and the smallest quantity in winter. A great deal of water is formed from the oxidizing, or burning, of the foods in the body.

When should we drink water? A good rule to follow is to drink when thirsty. Another good rule is to drink a certain quantity of water at regular intervals, whether thirsty or not, thus anticipating thirst. Formerly it was quite generally believed that we should not drink with our meals. This idea was a valuable one, although recent investigations have shown that

a considerable quantity of water may be taken at mealtime and not only not interfere with digestion, but even promote it. This is true if the food is very dry and is not well chewed.

My own idea is that it is better not to drink water when eating. During the process of chewing, the salivary glands are actively engaged in secreting saliva and mixing it with the food, a process useful to digestion, especially of starchy foods. To drink water while we are chewing our food decreases the activity of the salivary glands and thereby diminishes the flow of saliva. In short, although the water in itself is not harmful, it checks the secretion of saliva and its admixture with the food, and thus interferes with a process that is necessary for good digestion. Yet at the same time it is well to remember that the proper digestion of the food in the stomach and in the small intestine is checked if the contents of the stomach and the intestines are too dry. To my mind, the best plan is to drink water rather freely either before or directly after eating but to refrain from doing so during the meal in order that the salivary glands may properly perform their function.

At any rate, we should not neglect to drink water. If we eat five pounds of food a day, and water is included as food, nearly four pounds of it should be water.

When should we drink milk? Young children and growing children should drink milk at least three times a day. Milk is not only a beverage but a highly valuable food. It contains about eighty-seven per cent of water; to that extent it is a beverage. But the other thirteen per cent is made up of certain food elements so ideally balanced that all the tissues of the body are nourished and the best possible results secured.

Lunching on milk and brown bread

When I see a boy sitting at a table eating good brown bread made of whole-wheat flour, and drinking pure, clean, fresh milk from healthy cows, my heart rejoices, because I know that boy is getting the best possible food and in the very best form. When he adds to that vegetables and fruits and nuts, I rest entirely content, for he has all he needs to

nourish his body and properly promote growth.

Too often children, after the years of infancy and early childhood are past, abandon the habit of drinking milk. I believe it would be better if this habit were fostered rather than abandoned. A quart of milk a day is little enough for a growing child. But pure, clean milk is an expensive food. Happy indeed the family that can keep a cow, especially so if careful attention is paid to seeing that the cow is healthy, clean, and well fed.

What are the effects of sour milk on health? Most experts believe sour milk to be wholesome, and it is especially recommended in certain irritated conditions of the stomach in which ordinary fresh milk is not tolerated. Many persons believe that the constant use of sour milk, either buttermilk or ordinary sour milk, is not only wholesome but is conducive to long life. While I believe sour milk to be wholesome, and to that extent helpful in prolonging life, I do not believe that a diet of sour milk will relieve us of all the ills that necessarily attend old age.

Few people live to be a hundred years old, no matter what they eat or drink, but many of us could come nearer to living one hundred years if we were more careful of what we ate and drank. Perhaps people who need more

acid might go a much longer way toward the century mark if they drank buttermilk or sour milk more freely.

A coffee tree

What is coffee? Coffee is the fruit of a small tree. The coffee tree is larger than a bush and smaller than a tree. The coffee berry is one of the most important agricultural products of Brazil, Mexico, Central America, the Hawaiian Islands, Java, Arabia, and other tropical parts of the world.

What are some of the principal varieties of coffee? Coffee is sold under the name of the country from which it comes, or the name of the town or port from which it is shipped. Sometimes it is sold under a brand or proprietary name given by the dealer. The greater part of the coffee used in the United States is grown in Brazil, whence it is shipped from two great ports, Rio de Janeiro and Santos. The coffee shipped by way of Rio de Janeiro is called Rio, and that shipped from the Santos harbor is called Santos coffee. The most celebrated

coffees on the market are those produced in Arabia, and known to the trade chiefly as Mocha. In the Dutch East Indies a very fine grade of coffee is also produced, which is incorrectly known as Java. The island of Java itself does not produce a high-grade coffee, but it has given its name to the coffees produced in the Dutch East Indies. A high-grade coffee is also grown in small quantities in Mexico, Porto Rico, and the Hawaiian Islands. These varieties, however, are not important as to quantity, though often of most excellent quality.

What are the various grades of coffee? Coffees are divided into nine grades, numbered from one to eight, while the lowest grade is known as "no grade." The classification of coffees is determined chiefly by the number of defective grains. Grade No. 1 is supposed to have practically no defective grains. In Grade No. 2 are a few defective grains, in Grade No. 3 a few more than in No. 2, and so on in increasing numbers up to Grade No. 8.

Why is coffee roasted? Coffee grains that have not been roasted are so extremely tough that it is difficult to grind them. Besides, they are not palatable in that state and would not make good coffee to drink. The roasting of the grain develops its aromatic properties and makes the grain brittle, easy to grind, and

suitable for making the popular beverage known as coffee.

What are the active principles contained in coffee? The aroma and flavor of coffee are due to certain oils, developed by the roasting. The coffee berry also contains a considerable quantity of sugar, most of which is converted into caramel, or burnt sugar, during the process of roasting. It is chiefly this burnt sugar which gives the color and part of the taste to the beverage made from the coffee berry.

But the most active principle in coffee does not have any noticeable taste or odor. This is the element, however, that produces the exhilaration, animation or liveliness, that is felt after drinking coffee. The name of this substance is *caffeine.* It is the same as the *theine* found in tea. Caffeine belongs to that class of bodies known as *alkaloids*, other common types of which are quinine, morphine, cocaine, and nicotine. Alkaloids as a rule are poisonous. Caffeine is not a poison, as that term is generally understood, but it is a substance which may produce serious injury when taken constantly or in too large quantities.

There is also a considerable quantity of *tannin* in coffee. Tannin adds something to the taste of coffee but little or nothing to its wholesomeness.

What is the effect of caffeine upon health? Grown persons who are strong, vigorous, and well nourished are able to drink coffee in moderate quantities without any apparent harm. With children the case is quite different. I do not believe that any child can possibly drink coffee, even in small quantities, without being harmed. It is a beverage, therefore, which should be rigidly excluded from the diet of children. In my opinion no one should drink coffee before the age of at least eighteen years, if ever. It would be better if the habit were never formed.

Coffee acts especially as a stimulant. If one feels tired because of physical or mental exertion, that is nature's signal that one should rest. If instead of resting the tired person drinks a cup of strong coffee, the feeling of fatigue will disappear and he may then undertake additional labor. Such labor, however, is done at the expense of tissues already exhausted, and cannot be regarded as healthful exertion. It is far better to rest when you feel tired than to drive away signals of distress by taking any stimulant, even one so mild as coffee. Even grown persons who drink coffee should do so in moderation.

Are all people equally susceptible to the influence of coffee? Some people are able to drink large

quantities of coffee without apparent harm; others are affected by a very small quantity. Many grown people who drink a cup of coffee late at night find as a result that their sleep is disturbed, often during the entire night. Others may drink three, four, or even five cups of coffee during the day and not suffer from sleeplessness. But I do not believe it advisable to take stimulants except in emergencies where they will help to carry one over a certain period in which extra exertion is absolutely necessary.

The person who continually works under a stimulus may not feel it for many years, but he is almost certain to break down before his natural time. The drinking of coffee, therefore, cannot in most cases be regarded in any other light than as dangerous to health, and coffee should never be given to children.

What can be said of the practice of tea drinking? There is much difference of opinion among experts who have studied this question as to which is more harmful, tea or coffee. In a question of this kind it is well to give both sides the benefit of the doubt.

I am speaking now in the interest of the child especially. Grown people undoubtedly have the right to use tea and coffee as they see fit, but even they should use them temperately. *The use of tea and coffee tends to establish a habit.*

Some people begin their day by drinking one, two, or more cups of strong tea or coffee. If for any reason they are deprived of this stimulant they are miserable the rest of the morning. Very soon they have a headache and do not feel inclined to do anything but find fault.

A branch of the tea plant

Whenever you eat or drink anything which has practically no food value, and you are made unhappy when forced to do without it, you may be sure its use has become a habit and is injurious. Recently a census was taken among the school children of a large city in order to discover how many of the pupils drank tea or coffee for breakfast. About half of the children testified that they did. Thus the fear that tea and coffee may become a real danger to the children of the country is not an idle one, if we accept as true the statement that one half of the children in school are forming the tea and coffee drinking habit.

A short time ago the health officers of the city of Washington issued a circular to the parents whose children attended the public schools urging them not to allow their children to drink tea or coffee. The circular stated that children who were in the habit of drinking tea and coffee were restless, more or less disobedient, negligent of their studies, and were physically unfit to do good work in school. Competent authorities on diet all practically agree that children should not drink tea or coffee at any time.

What is the active principle contained in tea? The active principle in tea is known as *theine*, a substance that is identical with caffeine. Caffeine is the proper scientific term for both. Tea, like coffee, also contains large quantities of tannin. This substance acts on the pores of the membranes lining the intestinal tract, tending to contract them and stop them up. This is easily proved by placing a little tannin in the mouth. The mouth at once feels, as we say, puckered. Any one who has eaten a persimmon that was not ripe understands this sensation or feeling. The unripe persimmon contains large quantities of tannin, which produces the effect described. Considerable quantities of tannin introduced into a child's stomach in tea and coffee tend to hinder digestion,

produce constipation, and are thus injurious to his health. This statement is made in the full knowledge that most of the vegetable foods we eat contain more or less tannin, and that it is not possible to exclude it entirely from the diet. But we should not take any more of it than we have to, and above all it is not necessary to take it in such beverages as tea and coffee, which are stimulants and in no sense of the word foods.

Weight for weight, tea contains more caffeine than coffee. But the quantity of tea leaves used in making tea is smaller than the quantity of coffee grains necessary to make coffee, hence in a general way we say that a cup of tea and a cup of coffee contain about the same quantity of caffeine.

Where does tea grow? Tea is a plant that is native to semi-tropical regions. China and Japan are great tea-producing countries. Tea also thrives in South Carolina, and can be grown in other sections of the southern part of the United States. But it is cultivated in this country only near Charleston, South Carolina. There the late Professor Shepard developed an extensive and successful tea garden.

What part of the tea plant is used in making the beverage? The tea bought and sold in stores is the dried leaf of the tea plant. This leaf is

gathered by hand and dried. It is then rolled, a process often performed by hand. So you

Picking tea in a Japanese tea orchard

see it requires a good deal of hand labor properly to harvest and prepare the tea leaves for market. For this reason the cultivation of tea can be made to pay only in those countries

where labor is very cheap. The laborers on tea plantations are paid only a few cents a day.

The principal reason why tea is not grown in the United States is the high cost of labor here.

Machines have been invented to perform some of this labor, but as yet no machine has been invented that will pick the perfect tea leaves and reject those that are unfit for use. It is exactly like picking cotton, which can be done successfully only by hand, because the cotton bolls do not all ripen at the same time. For this reason each cotton field has to be gone over two or three times during the season in order to gather a full harvest. This is also true of the tea plant. The leaves cannot all be harvested at the same time because they do not all mature, or reach their full growth, at the same time.

What countries drink the most tea? The great tea-drinking countries of the world are England and Russia. In these countries all who can afford to do so drink tea. The United States, Australia, and Canada also use a great deal of tea. Although in the United States it is used extensively, tea is by no means so universal a beverage as coffee. The amount of tea used annually in the United States is approximately one pound per person, while the amount of coffee used is ten pounds per person. These figures

indicate the magnitude of coffee drinking in the United States as compared with tea drinking.

In Russia I have gone into business offices and into banks and found everybody engaged in drinking tea, and had to wait to transact my business until they had finished. In Russia tea is served in the banks about ten o'clock in the morning and at three o'clock in the afternoon, when for ten or fifteen minutes everybody quits business and drinks tea. Tea is not so commonly served in business places in England, but everywhere in that country in restaurants and private houses it is served from four to five o'clock in the afternoon, and also at meals.

The universal use of large quantities of coffee and tea cannot be regarded as harmless. Extreme temperance in the use of these beverages must always be observed if the health of the drinker is to be maintained. As we have already said, so far as children are concerned, none at all should be drunk.

What is cocoa? Cocoa is a beverage prepared from the nuts of a tree, the *Theobroma cacao*, and is very highly prized throughout the world. The cacao tree grows only in tropical regions, and for that reason all the cocoa used in this country must be imported. The nut of the cacao tree contains an alkaloid similar to that

of tea and coffee, namely, *theobromine*. The word theobromine means "food for the gods." Cocoa also contains small quantities of caffeine. Theobromine and caffeine are closely related to each other chemically and have a similar effect on the nerves. Both are stimulants. Theobromine, however, is much less stimulating than caffeine, and for that reason is regarded as much less dangerous to health.

A cacao branch and nut

The cacao nuts, or *nibs* as they are called, contain a great deal of oil and a little sugar. A considerable amount of nourishment, especially oil, is taken when cocoa is used. Cocoa, therefore, has a food value, which is not true of tea and coffee. But while cocoa is less objectionable than tea or coffee, that does not make it a good thing for children. Children do not need anything of this kind. Milk and water are the only beverages that should be given a child.

Cocoa is not an extract of the cacao nut, but is made by grinding the whole nut, less about one half of its oil, to a fine powder, to which a certain quantity of either milk or water is added to make a suitable drink. It is used much less extensively in this country than either tea or coffee, but still a great many of our people prefer it to either. If grown people think they must have a stimulus of this kind, it is probably better that they should drink cocoa than tea or coffee. Although much milder than tea or coffee in its effect, the use of cocoa should nevertheless be guided by temperance.

What is chocolate? Chocolate is cocoa in a slightly different form. The only difference between them is that in the manufacture of cocoa a portion of the oil of the nut is extracted so that it may be more easily powdered and manipulated. In chocolate all of the oil of the cacao nut is retained. Hence chocolate is much more nutritious than cocoa, because of the greater amount of fat it contains. So far as its stimulating effect is concerned, chocolate is less stimulating than cocoa, since it contains more oil or fat and consequently less theobromine and caffeine.

What is the chocolate used as a confection? Chocolate is used very extensively in the manufacture of confections. It has a dark brown

color, and when mixed with sugar is extremely agreeable to the taste. For this reason the amount of chocolate caramels, chocolate drops, and cake chocolate used as confectionery is very large. Sometimes the chocolate is mixed with milk and also with sugar, to make the well-known milk chocolates. For persons engaged in hard labor these sweetened chocolates are excellent foods. But they are not suitable for children to eat. They unbalance the ration, add a stimulant to the food which the child does not need, and create a taste for sweets which, if indulged, must necessarily interfere with the health and general welfare of the child. Chocolate candies should be eaten only by grown people who work hard, and should not be eaten by growing children.

What are the so-called soft drinks? Soft drinks are beverages which do not contain alcohol. I do not know why the term "soft" is applied to beverages of this kind, unless it is by contrast. Fermented cider is called "hard cider," and this term may have passed over from fermented cider to other beverages containing alcohol.

What are the principal varieties of soft drinks on the market? There is a very great number of soft drinks on the market. They consist of two general classes, those that contain sugar, bitter extracts, spices, and so on, and those

that in addition to these things contain an alkaloid. Intermediate between these two there is another class commonly known as "root beers." Root beers are supposed to be made of extracts from aromatic or medicinal roots, to which sugar is added and also a yeast which produces a slight degree of fermentation. The amount of alcohol in root beers is not large, and it may be some of them contain none at all. There is another large class of soft drinks known as "pop."

The soft drinks to which alkaloids have been added are known to the trade by many different names, but at the present time they consist almost entirely of those which contain caffeine. Caffeine is the active principle, as you have already learned, in tea and coffee. In tea and coffee the caffeine exists naturally in combination with other elements. This fact tends to limit its activity. In soft drinks to which caffeine has been added we find the pure alkaloid, which has usually been obtained from the sweepings of the tea factory and from other wastes from the manufacture of products containing caffeine. In this free state it may well be considered more active, and for that reason more dangerous to health, than when used in its natural state in tea and coffee.

A few years ago soft drinks which contained

cocaine were sold. But the war against cocaine has been so vigorous that the sale of all such drinks has been practically stopped.

Ginger ale is a type of soft drink which contains no alcohol and no added alkaloid. It is supposed to get its pungency from the use of an extract of ginger, but quite frequently much of its pungency results from the use of extract of capsicum, or pepper. In fact, pepper ale, or capsicum ale, would often be a better name for it than ginger ale.

What is the effect of soft drinks on the health of the child? Alkaloids are found in some soft drinks, and these substances are especially harmful to the child. I do not believe that children should be given soft drinks that contain alcohol in any quantity, nor any added alkaloid, such as caffeine. The child that is not allowed to use tea or coffee at home should not be allowed to drink soft drinks containing cocaine, caffeine, or alcohol. Stores, therefore, should not be permitted to sell children soft drinks containing these harmful drugs.

Another objection to soft drinks is that as a rule they contain large quantities of sugar. The child does not need any more sugar than he gets naturally in such food as milk and fruits. Neither should such extracts as spices, ginger,

and capsicum, which are used in soft drinks, have a place in the child's diet. All the sugar and condiments necessary to his welfare are supplied in the simple, wholesome food every child should eat.

What are alcoholic drinks? Beverages which contain alcohol in any quantity or form are known as alcoholic drinks. These drinks are divided into two great classes, fermented beverages and distilled beverages. The chief fermented beverages are wine, beer, and hard cider. Wine, for instance, is made from the juice of ripe grapes that has been allowed to ferment.

What causes the fermentation? The fermentation of grape juice and other liquids containing sugar is caused by the presence of a vegetable organism which we call yeast. There are many different kinds of yeast, producing different flavors, but all of them have this property in common — they can convert sugar into alcohol and carbon dioxide. Grape juice contains from fourteen to twenty-six per cent of sugar. When the sugar in grape juice is fermented the quantity of alcohol produced is about one half the total quantity of sugar. Grape juice containing fourteen per cent of sugar would make a wine containing approximately seven per cent of alcohol. On the other hand, if the grape juice

A vineyard in the foothills

contained twenty-six per cent of sugar it would make a wine containing approximately thirteen per cent of alcohol. The juice of apples contains from eight to sixteen per cent of sugar. If fermented it would produce a cider which would contain from four to eight per cent of alcohol. The fermented cider is called "hard cider," to distinguish it from unfermented cider. Wine and cider are the principal beverages which ferment by their own natural yeasts and do not need the addition of any other fermenting agent.

What is beer? Beer is a fermented beverage made from cereals and hops. Barley is the

chief cereal used in making beer. Beer made in the United States contains from less than two per cent to a little more than four per cent of alcohol. When beer contains less than two per cent of alcohol it is commonly spoken of as non-intoxicating. Some people, however, may become intoxicated by drinking a quantity of beer containing only two per cent of alcohol. The term "lager" is applied to beer which has been placed in storage for some time. It requires from six to twelve months properly to age beer.

What is ale? Ale is the same as beer except that it is made of a heavier mash and contains from five to eight per cent of alcohol. By reason of its higher content or percentage of alcohol, ale is much more injurious than beer.

What is champagne? Champagne is a wine which is fermented in sealed bottles. It is made in a certain department or division of France only. Epernay and Rheims are the chief cities of this region. Wine fermented in the bottle in other localities is known as sparkling wine. When the corks are removed from the bottles containing such wines quantities of gas escape from the liquid, forming small bubbles which for a long time continue to rise to the surface.

What relation have these fermented beverages to health? In so far as children are concerned, the use of fermented beverages is very injurious to health, even when they are consumed in small quantities. Alcohol is a habit-forming drug, and when one once begins to use it he is apt to like it a little better each day, and thus be inclined to take more and more of it. Therein lies the chief danger.

What is grape juice? Grape juice is a beverage made from the unfermented juice of grapes. The juice is heated so as to kill all the yeasts or fermenting substances in it, and is then set aside to allow the solid matters to settle. After a few days, when the grape juice is bright and clear, it is put into bottles, sealed air-tight, and subjected for a certain length of time to a temperature under the boiling point of water. Juices put up in this way remain bright and clear, and will keep almost indefinitely until opened.

Grape juice is not only a pleasant drink but also has food properties, due chiefly to the sugars it contains. It also has acid properties, due chiefly to the tartaric acid contained in it. These acid properties are thought to be favorable to health, not because of the acid, but by reason of the base—potash—which they carry. Well-made and well-preserved grape juice and

cider are palatable and wholesome. They may be used occasionally by children, but only in small quantities.

What about distilled liquors? The principal distilled beverages are whisky, brandy, rum, and gin. Whisky is made from fermented cereals in the same way that beer is made, except that no hops are added. After the cereals are fully

A small still for the distillation of liquors

fermented the mash is put into a large copper vessel and distilled. The raw whisky produced by this process of distillation is then placed in oak barrels and stored for a number of years. Usually it requires about four years to ripen it.

Brandy is made by distilling wine. It is therefore an alcoholic product of the grape. Rum is a product distilled from fermented

molasses, just as whisky is distilled from fermented cereals. The peculiar aroma of rum comes from the sugar cane from which the molasses is made. Gin is distilled alcohol of any kind flavored with certain substances, such as juniper and sloe berries.

To make the vast array of alcoholic products known as liquors, cordials, cocktails, and so on, alcohol is mixed with sugar and other substances, principally flavors and colors. All such mixtures are put to their best use when left entirely alone. Some alcoholic products, like absinthe, contain substances so poisonous in nature that they produce the most dreadful effects on those who continue their use. The manufacture and sale of alcoholic beverages of all kinds in the United States is carefully supervised by the government. Taxes imposed on the industry yield large sums to the public treasury. But the fact that high taxes are payed on alcoholic beverages in no way justifies their manufacture and use.

Those who use alcoholic beverages are less efficient in their work, and have less resistance to cold because fatigued more easily. They are far more likely to have a diseased liver, or tuberculosis and pneumonia than total abstainers. They are often shut out from useful employment. The Pennsylvania railroad will

not employ anyone who uses alcohol. It does not allow alcoholic beverages to be sold on its dining cars. Many industries are endeavoring to have only employees who are total abstainers. Why should a boy form a habit which will handicap him through life and bring him prematurely to the grave?

XXIV. Confections, Sirups, and Pastry

What are candies? We are coming now to the most difficult part of our task — not actually difficult to perform, but difficult because of the disappointment that must result. But I must tell the truth about candies and their effect upon health, even though for a time I gain the ill-will of the children.

Candies are products made chiefly of sugar, with the addition of coloring and flavoring matters, and put up in various shapes and forms attractive to the eye. The terms "candies" and "confections" do not mean quite the same thing, although a candy is always a confection and a confection may be a candy. Confections are products which may contain fruit in addition to the elements that are used in making candies. Both candies and confections are often spoken of under the general name of confectionery. A jam or jelly is a confection, but not a candy. On the other hand, any candy, since it is made up of more than one element, is correctly called a confection. The word "confection" means a product made by bringing several ingredients together.

What sugars are chiefly used in the making of candies? The term "sugar" when used alone

means the ordinary sugar of commerce. The sugar we buy in the grocery store is made chiefly from two plants, the sugar cane and the sugar beet. Small quantities of sugar made from the maple tree may be found on the market, and in some parts of the world sugar is produced from other plants, as for instance the sugar palm. At least four fifths, and possibly a larger proportion, of the sugar used in the United States is made from sugar cane.

Sugar cane grows in the southern part of the United States, especially in Louisiana. It is found in other states, but Louisiana is the leading state in the Union in the production of cane sugar. Sugar cane grows luxuriantly in rich soil that has been properly tilled. It looks like corn and sorghum. It has a jointed stalk, and often grows to a great height, bearing blades at each joint. As it ripens, the sugar cane becomes so heavy that it hardly ever stands up straight. It falls over, especially during a heavy wind, becoming a tangled mass that seemingly would make the harvester's task almost hopeless.

Cuba makes more cane sugar than any other country. Its annual production of cane sugar is now about three million tons. Over three hundred thousand tons of cane sugar are made in some seasons in Louisiana, and over five

hundred thousand tons are made in the Hawaiian Islands. Porto Rico and the Philippine Islands also produce a large quantity of cane sugar. Cuba, however, is the principal source of the cane sugar imported into this country.

Sugar beets grow in more northern latitudes. In this country the great beet-growing states are Michigan, Colorado, and California. The beet often carries from fourteen to eighteen per cent of sugar. It is thus richer in sugar than the sugar cane raised in this country, which usually carries only from eleven to thirteen per cent. The sugar cane of Cuba and that of the Hawaiian Islands, however, is often richer in sugar than are beets.

In the manufacture of beet sugar the beets are cut into very fine slices and placed in large vessels. The sugar is then extracted by means of hot water. Refined beet sugar is so like refined cane sugar that only a trained expert can tell the difference. Cane sugar is generally preferred for candy making, for if the beet sugar is the least bit impure it will give a disagreeable flavor or taste to the candy.

What ingredients are mixed with sugar in making candies? Usually some coloring material is used, as we demand a variety of colors in our candies. These coloring matters are either coal-tar or vegetable dyes. Various flavoring

matters, such as cinnamon, peppermint, chocolate, almond, cocoanut, and other substances

Pulling homemade taffy

are mixed with the sugar to give each kind of candy a particular flavor. It requires great skill and long practice to make attractive candies.

Can we make candy at home? One of the most enjoyable pastimes on a cold winter evening is the making of so-called "taffy." In former years, when old-fashioned New Orleans molasses was to be had, it was easy to get good raw material suitable for making taffy. This is now a difficult matter. The ordinary sirup sold for use at breakfast is not suitable for high-grade taffy. You must first get a genuine sugar-cane

sirup or good New Orleans molasses if you wish to make a good first-class, taffy. Then you must boil the molasses or sirup, stirring carefully so as not to let it scorch, until a spoonful dropped into cold water makes a waxy, hard mass. The boiling sirup is then poured into greased plates and set in a cool place until it begins to harden. It is then taken out and pulled vigorously. During this process it takes in a large number of small air particles and changes in color to yellow or, when the sirup is very pure, almost to white. Such taffy is excellent from the candy eater's point of view. It is not so easy to make fancy candy at home, but candies like fudge are made there extensively.

Are injurious substances used in making candy? Unfortunately, yes. Within the last few years some candies have been coated with a soluble gum in order to give them a certain gloss or finish. This coating has sometimes been found to contain arsenic, which is dangerous to the health of the consumer. The dyes that were formerly used were uncertified coal-tar dyes and as such were more or less poisonous. Fortunately, the food laws have practically succeeded in stopping the use of such materials. To-day a number of manufacturers use only pure vegetable substances in making candies.

Moreover, their candies, which are highly attractive in color and glazing, contain no poisonous substances and are so made that from the stand point of purity they are perfectly safe.

The ingredients themselves used in making candy may be regarded as harmless. That is, there is in them no special danger. Sugar, chocolate, spices such as cinnamon and peppermint, honey, butter, and such other substances cannot be regarded as harmful.

Candies are also made to a considerable extent of glucose, a product derived from the starch of Indian corn or of the potato by treating it with an acid at a high temperature. Most authorities regard glucose as harmless. However, since glucose is an unnatural sugar, that is, a sugar not made in the natural way, I believe it may contain properties that are injurious to health. It is a well-known fact that very young animals, such as mice and chickens, fed with glucose instead of ordinary sugar, do not thrive. This is true also of bees. So, if I were prescribing candy for children (which I never do), I should prefer to recommend candies which contain no glucose.

In conclusion I may say that, owing to the efficiency of state and national laws, well-made candy, when it is eaten in moderation, may be regarded as harmless for grown people.

What effect has the eating of candy on the health of the consumer? Aside from the nature of the ingredients it contains, I must say most emphatically that candy is not a suitable food for children. It contains practically no material which will build or restore tissue, but consists essentially of sugar, which, as a food, produces only fat, heat, and energy. Hence children who eat large quantities of candy unbalance their ration and in that way it becomes harmful. The bones and teeth are not well nourished, the nitrogenous tissues of the body suffer from hunger, and the work that food in general is supposed to do is hindered. Unfortunately, candy is eaten chiefly between meals, which renders it an additional danger to health.

If older children engaged in active exercise and hard work wish to eat candy, they can get a good deal of strength and energy out of it, and it will thus be of use to them. But as a food for young children candy in any noticeable quantity must always be considered dangerous.

What is the effect of candy upon the teeth? It is generally admitted by everybody that children who eat a great deal of candy have poor teeth. The real danger to good health in eating candy is that the child is deprived of those elements which are suitable for building bone and teeth. If there is not enough of these elements in the

blood, nature robs the teeth to strengthen the bones, and thus in early childhood the teeth deteriorate. Even the first set of teeth may be soft and prone to decay, and premature decay threatens not only the tooth attacked but the permanent tooth that is to come after. Hence during the teething period, which lasts up to ten or twelve years, the quantity of sweets — that is, candy — which should be given to the child is best represented by zero. If the child never acquires a "sweet tooth" as it is called, he will not cry for sweets. He will be content to eat the foods in which nature has provided all the sugar he needs. Candy, therefore, in any form or shape, is injurious to the teeth and is in my opinion not suitable for young children or for growing children.

A bad set of teeth. "Not healthful or pretty"

What is meant by the word "sirup"? The term "sirup" properly applied means a product consisting essentially of sugar made by the evaporation of the sap or juice of a sugar-producing plant until it becomes a thick, somewhat viscid or sticky mass. The most common sirups in

use in the United States are made from the sap of the maple tree, sorghum, or sugar cane. These products are called maple sirup, sorghum sirup, and cane sirup. The sap of the sugar beet, although it carries a large quantity of sugar, does not make a palatable sirup because of the large quantity of mineral salts, mostly potash, soda, and lime, contained in it. When this sap is evaporated to the consistency of a sirup it tastes bitter or salty and is not commonly used for food.

Are there any other kinds of sirups besides those mentioned? Unfortunately, most of the sirups on the market in our country are not the pure products mentioned above. Maple sirup, sorghum sirup, and cane sirup have distinctive flavors and qualities which enable even one who is not an expert to distinguish one from the other. Nearly every one in this country is familiar with the taste of maple sirup, its flavor and its qualities. All those people who live along the Ohio River especially, and those who live in Kansas, Missouri, and Illinois, are familiar with the taste and flavor of sorghum sirup. The people of the country living in the southern states, especially in Texas, Louisiana, Alabama, Mississippi, Georgia, Florida, and South Carolina, are familiar with the taste and flavor of cane sirup.

Unfortunately, these excellent products are employed as a flavor for making manufactured sirups, when they are mixed with large quantities of glucose.

What is glucose? Glucose is a thick, sirupy product, almost or quite colorless, which is produced from starch, mostly derived from corn. We have already learned how this product is used in the manufacture of some kinds of candy. Glucose is faintly sweet, but is otherwise flavorless, and is not sufficiently palatable to be eaten alone. When mixed with one of the sirups mentioned it acquires the character and flavor of the particular sirup of which it becomes a part. It dilutes or thins the sirup, adds to its bulk, lightens its color, and makes an attractive product which is used extensively throughout the country. Melted brown sugar is also used as a sirup. It is often mixed with glucose, or with some of the genuine sirups that have already been mentioned.

When you go to the grocery store and buy a sirup it may or may not be correctly labeled. That will depend upon the strictness with which law is enforced and the honesty of the manufacturer and the dealer. The chances are that if you simply ask for a sirup you will get neither maple, sorghum, nor cane sirup, but such a mixture as we have described. These mixed

sirups naturally do not have the character or the flavor of the pure articles, although as a rule they are palatable and satisfactory, especially to those who are not well acquainted with pure sirups.

What is the food value of a sirup? A pure sirup or a manufactured sirup depends for its chief food value on the sugar or sugars which it contains. All sugars have practically the same food value. They are burned in the body completely when it is in a state of health, and furnish heat and energy. In this way sirups unbalance the proportion of food elements necessary for proper nourishment and for this reason should be eaten very sparingly, especially by children. For people engaged in hard work, or those who take a great deal of physical exercise, they may be safely eaten in quantities and prove beneficial. If these sirups are not completely burned they may be transformed into fat, and thus increase the fat content of the body above the normal.

Do sirups have any other value? The pure sirups contain mineral substances which are also useful to the body. All natural sirups — maple, sorghum, and cane — contain from two to three per cent of mineral substances, which are valuable aids to digestion and promote health. These substances, such as lime, phosphorus, soda, and potash, are useful in building bone

and teeth and other tissues of the body and in producing the alkalinity of the blood which is needed to help the heart and other organs do their work. So it is plainly to be seen that if one desires to eat sugar it is best eaten in the form of natural sirups, because of the mineral nutrition which they afford. The lime and the potash, elements found in sirups, are not the only minerals they contain. Traces of iron, magnesia, soda, silica, and other minerals which are in solution in the soil are present in the sirups, and these minerals are also aids to nutrition. Candies made from these sirups are to be preferred to all others for children. Children might be permitted the moderate use of such candies made from pure maple, sorghum, or cane sirup, provided that the habit of eating sweets does not become so strong that they crave larger quantities than are good for them.

How does sirup affect the health? This question has already been answered more or less completely. Natural sirups are wholesome when not eaten in too great quantities. When any one engages in active play or manual labor these sirups may be eaten without fear of injurious results. If the sirups are eaten with other things that are rich in protein or fat they more nearly form a balanced ration. Sirups may therefore be eaten with advantage with

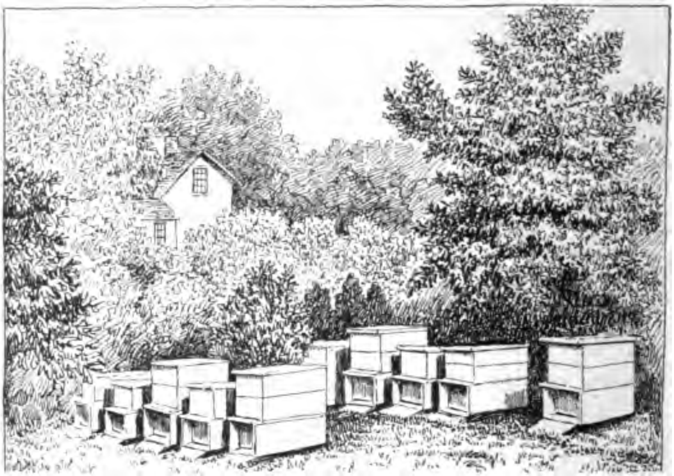
cakes made out of cereals rich in protein, especially so if butter is also used on the cakes. We then have a more or less well balanced ration. The butter furnishes the fat, the cereals furnish the starch, the protein, and a part of the mineral matter, and the sirup furnishes the sugar and also a considerable quantity of mineral matter. If children eat sugar at all it should be eaten in this way, but always in moderation. These sirups may be regarded as wholesome, as not in any way endangering proper nutrition, and therefore as healthful.

On the other hand, the sirups made out of melted white sugar, or the sirups composed mostly of glucose, a product formed by violent chemical action and not by natural processes, are not to be regarded as either so wholesome or so desirable as the pure sirups.

Glucose contains almost no mineral matter except common salt. Salt is a wholesome and necessary ingredient of our food, and hence is not objectionable in the quantities in which it is present in glucose. Nevertheless we can get plenty of salt from other kinds of foods, and it should not be necessary to eat glucose in order to get it. On the other hand, the true sirups contain a large number of mineral ingredients, all useful in digestion and nutrition, which are not present in the manufactured sirups.

What is honey? All plants produce more or less sugar during their growth. Some are known particularly as sugar-producing plants because of the large quantity of sugar they contain. Among these are the maple tree, the sugar palm, sorghum, sugar cane, and many varieties of garden beets and other garden vegetables, sweet corn, melons, fruits, and grapes.

At the time of flowering almost all plants give out a large quantity of sugar in connection with the bloom. The sugar, or *nectar* as it is called, attracts the visits of bees and other insects that gather honey for food. These insects in

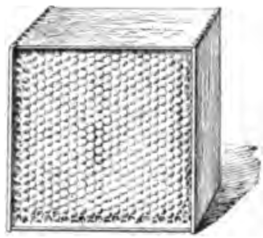


A colony of bees

passing from flower to flower carry the pollen, which fructifies or fertilizes the flower and

makes it possible to produce fruit. So you see the sugar found in flowers has an important function to perform in the life history of plants.

Honey is gathered by an insect known as the honey bee. Many thousands of these bees live in one family or colony. During the season of flowering they go long distances and bring back little stores of sugar for the common storehouse of the family. They build little five-sided houses or rooms, usually in hollow trees or in hives, and fill them with this honey after it has passed through



Honey comb

their bodies. The bees also secrete a peculiar form of acid, called *formic* acid from the Latin name of ant. A little of this acid is also imparted to the honey, which helps to give it its peculiar and distinctive flavor.

Honey is a form of sugar highly prized by almost every one. There are very few people who do not like honey. It is eaten exactly as sirup is eaten, by spreading it on bread or cakes or using it in making sweet cakes. Bee keeping is carried on in all parts of the country. The bees are provided with little houses called hives, in which they store their honey. Large quantities of honey are produced, especially in California, where the bees gather their honey

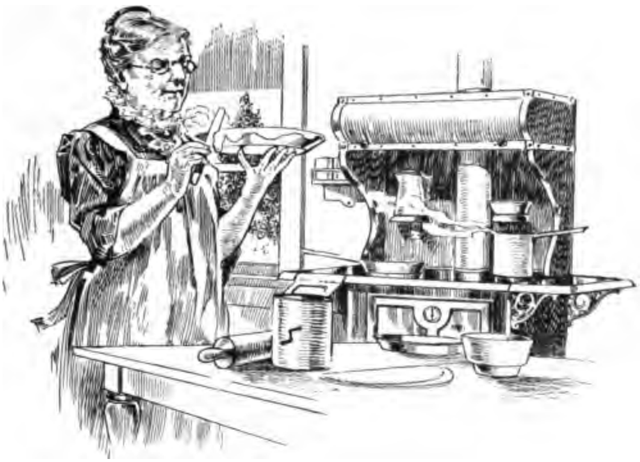
largely from the wild sage of the deserts and from the flowers of the many fruit trees.

Is honey a good food? Honey is a food which depends for its value on the sugar it contains. Therefore it is an unbalanced ration and should be eaten in moderation, especially by children. Honey contains very little mineral matter, the sugar gathered by bees being remarkably pure. So honey is not so well adapted to promote the growth of the body as sirups made from the maple tree, sorghum, or sugar cane. Honey should be eaten very sparingly by children, but for grown persons who do hard work it is an excellent food, as it furnishes a large amount of heat and energy.

Is honey good for the health? Pure honey, when eaten in small quantities, cannot be regarded as harmful or injurious to health. But sometimes the bees gather poisonous substances, or in some way introduce poisonous matter into honey, so there are cases on record of severe poisoning due to the eating of honey. For this reason it is always advisable to eat honey temperately, for even good honey if eaten in too large quantities may cause severe illness.

The taste of honey is so attractive that it is difficult to control the appetite for it. For this reason, when children eat honey the quantity they are allowed to have should be measured

out by their parents and no more should be given, even if the children cry for it. Otherwise



Homemade pastry. Making pies

the results from eating honey may be serious.

What is pastry? The term "pastry" is the name given to such foods as pies, patties, and tarts. First a holder or container is made from a dough of wheat flour to which a large amount of fat, or shortening, has been added. This holder or container is then filled with fruits, meats, sugar, spices, or other things, and baked. Pastry is served at the end of the meal, as dessert. Usually when we come to pastry we have already had enough to satisfy our hunger. So the pastry we eat is only an added burden to digestion, which is really the chief objection

to its use. However, if we stop eating while still a little hungry, and then have the pastry, no harm will be done, for there is no great objection to a moderate use of such food. This is especially true of fruit pies.

In England by the term "pie" is usually meant only pastry in which the filling consists of meat. In this country the term "pie" is used no matter what the filling may be. In fact, most of our pies are made with vegetable, fruit, or custard filling, a very small proportion only being made with meat filling. Even mince pie, which is supposed to contain meat, generally contains very little of it, especially if it is not made at home. The filling is principally made up of fruits, raisins, sugar, and similar things.

Small fruits, especially berries and cherries in season, are used largely in the making of pies. Pies are usually made in a certain shape and of a uniform size, being commonly in the form of a disk, from six to eight inches in diameter and nearly an inch thick. Though pies are usually this size and form, they may have other shapes.

The fillings used in pies made in this country are chiefly apple, peach, cherry, blackberry, raspberry, pumpkin, custard, lemon, and mincemeat. Strawberries are often served in a kind

of pie known as strawberry shortcake, in which the crust and the fruit are placed in successive layers.

Are pies digestible? The piecrust is made of digestible materials in which the large percentage of fat makes an unbalanced ration. Many persons believe that fat mixed with flour and baked in pies is not so digestible as the flour and the fat eaten separately. This is probably true, but since pie is usually eaten at a time when no more food is needed, it seems probable that the indigestion noticed after eating it is due more to an excess of food in the stomach than it is to the piecrust.

Fat and flour are digested in different parts of the alimentary canal. They are blended so closely in piecrust and similar articles as to interfere to a certain extent with the digestion of each. For instance, protein, which is found in piecrust, is digested largely in the stomach, while fat, of which the piecrust contains a great deal, is digested largely in the small intestine. The starch contained in the piecrust may be digested partly in the mouth and partly in the small intestine. When the fat is thoroughly mixed with these substances as it is in piecrust, the process of digestion may be interfered with because the protein and the starch are prevented from being acted upon by the *enzymes*. These

enzymes are digesting agents in the mouth and stomach which are necessary for the digestion of such foods. In the same way the particles of fat may be carried into the small intestine so closely intermingled with undigested protein or starch as to cause difficulty or delay in the digestion of the fat. Thus it is reasonable to suppose that the mixing together of fat and flour in piecrusts to a certain extent makes them difficult to digest. So pastry, although it may be highly nutritious, cannot be recommended as an easily digested food. It should be eaten in moderation, and if one has already had food enough completely to satisfy hunger when the pastry is served, then it should not be eaten at all.

To avoid overeating it has been suggested that pastry should be served at the beginning of a meal and not at the end. But I hardly approve of this suggestion. The principal object of eating is to nourish the body. Hence, in the order of eating, those foods which are best suited for our nourishment should be given the preference. To my way of thinking it would be better if pastry were not served at all, or, if served, it should be given in smaller quantities, especially to children. Pastry should be eaten under the same restrictions as sirups or preserves. At least, the growing child should eat very little

of it, while the hard-working grown person may eat it more freely.

What is ice cream? It is difficult to define a product which is made in so many different ways

Freezing ice cream at home

and out of so many different materials. I can define an ice cream which to my mind is properly called ice cream and is made out of the right kind of materials. Such ice cream is a product made by mixing with cream the proper amount of sugar and harmless flavoring matter and then freezing the mixture. It should contain no less than fourteen per cent of fat. A mixture of salt and ice is used for freezing the cream.

What is the food value of ice cream? The food value of ice cream is high, but it is not a well-balanced ration. The cream itself contains nitrogen (protein), butterfat, and milk sugar,

the percentage of fat being very high. In standard cream the content of fat is never less than eighteen per cent. To this cream is added a certain amount of sugar, a food which furnishes large quantities of heat and energy. Ice cream contains only very little protein and mineral salt (potash, phosphoric acid, lime). Thus it is a food which furnishes great quantities of fat, heat, and energy, and is well suited for grown people who take a good deal of physical exercise, but is not well suited to the nourishment of growing children. It should be eaten sparingly by children if injury to health is to be avoided. But children under the age of five years should not eat ice cream.

PART THREE

XXV. How Do We Grow?

A STUDY OF FOODS

What is the purpose of food? All living things require food. This is true of plants as well as of animals. The young plant gets its first nourishment from a supply of food stored in the seed. Some seeds, like nuts, are very large, and contain a great deal of nourishment. Other seeds are very small and so can contain only a small quantity of nourishment. But there is always food enough for the young plant during the first period of growth.

The seeds of all cereals contain enough food to sustain the young plants for several days without any additional supply. Then, if no further nourishment is provided, the young plants will die. You may prove this by a simple experiment. Fill two basins with distilled water. Distilled water contains practically no food that will promote plant growth. Over the surface of the water place cloths that have been thoroughly washed in

Sprouting cereals in water

distilled water to remove any material that might nourish the plant. The threads in the cloth must be far enough apart to leave space for young rootlets to grow down into the water. On top of the cloths place a number of grains of wheat, and set the two basins in a dark place where the temperature is not below fifty-five or sixty degrees. When the wheat has sprouted and is fully developed, bring the basins out into the light. The sprouts will soon turn green, and the roots will reach down through the cloth into the water. Gradually the grains of wheat will disappear, leaving only the hulls. Then the growth of the plant will cease.

Now add a little phosphate of soda, a little powdered gypsum, and a little nitrate of potash to the water in one of the basins. Then watch what takes place.

In the basin where you added the plant food the plants will grow vigorously as long as the plant food lasts. The young plants in the other basin, where no nourishment was added, will die. In the first case you fed the plant; in the second you starved it. Corn or any other cereal may be used for this experiment.

When an animal is born it can live two or three days without any nourishment. But very soon thereafter, if no food is given it, the young animal will die. Given the proper

nourishment, it will not only live, but it will continue to grow. Thus we see that in order to live and to grow both animals and plants must have an adequate supply of food.

How may the foods of animals be classified? In classifying foods suitable for animals, we find five principal divisions: *Mineral* foods (lime, phosphate, soda, potash), *nitrogenous* foods (protein), *carbohydrates* (sugar and starch), *oils* and *fats*, and *condiments* (seasonings). All the food we eat may be classified under these five heads.

Foods may also be classified according to other standards. Most foods may be classified as animal or vegetable products. With regard to their preparation they may be classified as cooked or raw foods. Classifying foods according to their natural form we have meats, poultry, fish, game, cereals, milk, fruits, vegetables, and nuts. With regard to the various forms in which they are prepared for use they may be classified as flour, bread, butter, cheese, cream, cured meats, smoked meats, dried fruits, canned fruits, canned vegetables, breakfast cereals, and prepared foods such as jams, jellies, and preserves.

In our discussion of foods we shall begin with the minerals.

A STUDY OF MINERAL FOODS

What are the chief minerals contained in foods? Nearly all the mineral substances that are present in the soil are also present in vegetable products. Animals must have some of these mineral foods in order to live; others are valuable at certain times and under certain conditions. The mineral substances that animals must have are phosphoric acid, lime, iron, soda, potash, iodine, and magnesia.

What foods contain the most iron? Some kinds of food contain a great deal more iron than others. Of the vegetables, spinach is believed to contain the largest amount. There is also much iron in the cereals, and traces of it are to be found in most of the foods we eat.

Is there any danger in taking too much mineral substance into the body? The rule that applies to all other foods when taken in excess also applies to mineral substances. If more minerals are taken into the body than are required for its proper nourishment and growth, the body must get rid of the excess. This is done by the excretory organs of the body, especially the kidneys. Thus if an excess of minerals is taken into the body a greater burden than usual is placed on the excretory organs, and this, if continued, may prove harmful.

As a general rule the mineral content of our

food should equal about two per cent of the whole amount. In other words, when we eat one hundred pounds of food, about two pounds of it should consist of mineral substances. More than this would probably be harmful, and any considerable amount less would certainly be so. Therefore, in the preparation of food to be eaten, the natural mineral content should be reduced as little as possible. It is really better to eat the skins and outer coverings of foods, such as the bran of cereals and the skins of potatoes and apples, than it is to discard them, for by discarding them we diminish the mineral content of these food products.

A STUDY OF FOODS CONTAINING NITROGENOUS SUBSTANCES

What foods are the chief sources of nitrogen (protein)? Nitrogen, or protein, is present in nearly all our vegetable and animal foods. Among the foods containing the largest proportion of protein is lean meat. About sixty per cent of the content of ordinary fresh lean meat is water, the remaining forty per cent being largely protein and fat. Both red and white meats are made up mostly of protein and fat.

Milk is another animal food in which there is much protein. It contains three and a half per cent. Since eighty-seven out of the remaining

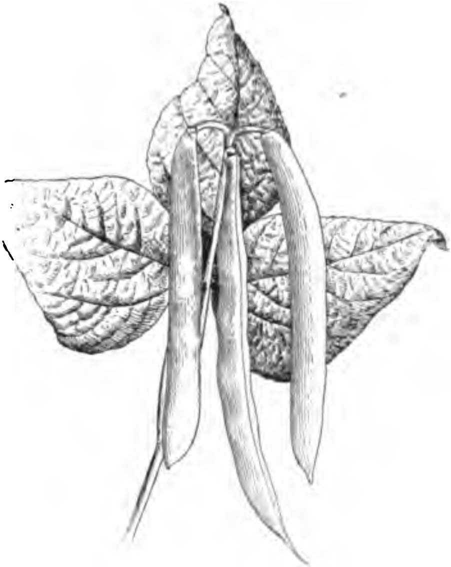
ninety-six and a half per cent is water, it is evident that a little more than one fourth of the total amount of dry food in milk is protein. In cheese the proportion of protein is considerably greater than in milk. There is also a large quantity of fat in cheese.

Pea pods

Another food containing a large proportion of protein is the egg. The white of an egg is more than seventy per cent water. The remainder, or thirty per cent, consists largely of protein. The yolk of an egg contains less water than the white of the egg, and also much less protein. A large part of the yolk of the egg consists of fat.

Among the vegetable foods, peas and beans are rich in protein. Among the cereals, oats contain the highest proportion of protein and rice the lowest. Not more than seven per cent of the content of rice is protein. From ten to fifteen per cent of the content of wheat is protein, while Indian corn contains less protein than wheat, or ten per cent, and barley and rye almost as much.

While peas and beans are very rich in protein, the amount in other vegetables is comparatively small. The percentage of protein in the potato is also small. Fruits and succulent vegetables also contain a comparatively small amount of protein. Nuts, and oily seeds such as cottonseed and flaxseed, contain much protein. From this we learn that if we should limit our diet to a single food we might select one with a very high content of protein, such as oats, peas, or beans, or we might select one with a very low content, such as rice, potatoes, or fruits. But if we know the proportion of protein in the various kinds of food we can select them so as to get the exact amount of protein needed for our sustenance and growth.



Bean pods

How much protein should we eat a day? This is a question that has been the subject of much

discussion. Some experts claim that we should eat a large quantity of protein; others claim that a small amount is better. The proper amount is probably found between these two estimates.

A man who weighs about one hundred fifty pounds and is engaged in active work needs from three and two tenths to four and three tenths ounces of protein a day. In a later chapter we shall discuss the quantity of different foodstuffs necessary to provide that amount of protein.

Are there differences in the nutritive qualities of proteins? The proteins in different kinds of food, both animal and vegetable, differ in nutritive value. Comparing the body to a house built of brick or stone the protein may aptly be regarded as the bricks or stones, out of which the structure is built. Protein is the essential material composing the muscular tissues of the body. It is also a very important element of the nerves and the brain, and is one of the chief substances in the blood. Protein is almost the sole content of the hair, the nails, and the skin. It is a very important element in the bones of the body. It is found, although in small quantities, even in the fats of the body. Thus the statement that protein is the principal building material in the bodily structure is fully justified.

You have noticed that different clays make different kinds of bricks. Some are red, some gray, some almost white, and some yellow. Some bricks are very hard, some have been

Protein "bricks" used in building the body

melted, or vitrified as it is called, until they are glassy, and some are so resistant to heat that they cannot be vitrified, and for that reason are used to line furnaces. And yet all bricks are made out of clay. In the same way we may

find differences in the protein "bricks" out of which the bodily structure is built.

Among the best protein bricks with which to build the human body are those made from the casein of milk and the gluten of wheat. The protein of Indian corn, if no other "clay" is mixed with it, makes the poorest bricks.

The proteins themselves are not bricks or building stones of the body any more than beds of clay or unquarried rocks are bricks or building stones of the house. Just as bricks are molded and baked in the kiln, the proteins are treated in the digestive apparatus and made into "building stones" or "bricks" suitable for the bodily structure.

When proteins are used in the body, whether they are built into the tissues or are oxidized or consumed directly in the *blood stream*, a waste material forms (urea) which is more or less injurious or poisonous. For this reason not more of this building material than is really necessary for the growth and nutrition of the body should be used.

The foods containing the largest proportions of protein are the most expensive, with the exception of a few fats (butter, olive oil). A nation that produces plenty of food, or has plenty of money with which to buy food, is apt to use the most expensive foods, such as meats,

eggs, and milk. Therefore the people of such a nation are apt to eat more protein than is good for them. On the other hand, if a nation produces little food, and has little money with which to buy food, it must content itself with foods that are poor in protein, such as rice, Indian corn, and potatoes. The people of such a nation no doubt get less of the building material than they need. But the nation whose resources permit it to take the middle course between these two extremes will have the advantage, since the people will get enough protein for building purposes and at the same time avoid an excess of waste material.

Growing children need more protein than grown people. They must not only replace old building material, but they must also provide building material for new growth. They must have material to repair the old building and at the same time bricks for the additions. For this reason the diet of children should contain proportionately a larger amount of protein than that of grown people. Milk, the natural food of the infant, contains a relatively small proportion of protein, because nature did not intend infants to grow very rapidly. Mother's milk contains a smaller proportion of protein than does the milk of the cow, since nature intended that the calf

should grow more rapidly than the human infant.

When children reach the age of six or seven years they begin to grow rapidly. Then cow's milk is better for them than the milk that was suitable when they were infants. There should be an abundance of protein in the food of a child during the period of rapid growth, which is usually between the ages of seven and seventeen years. After the seventeenth year the amount may be diminished with safety.

The amount of protein suitable for children of different ages will be taken up later.

A STUDY OF CARBOHYDRATES

What is the function of the starches and sugars contained in foods? Starches and sugars make up the greater part of human foods so far as weight and bulk are concerned. The chief function of the carbohydrates (starch and sugar) in nutrition is to produce heat and energy. At the same time the carbohydrates aid in the digestion and assimilation of other food substances and, to a certain degree, in forming fat tissues in the body. Because starch and sugar produce heat and energy when consumed or burned in the body, the carbohydrates are called fuel.

Nature intended that all the different classes of food—protein, the carbohydrates, fat, minerals,

and condiments—should be present in the ordinary processes of digestion. Each class of food, including the carbohydrates, exerts a profound influence on the relations of every other class in the process of digestion. Thus the nutritive value of each class of food can be studied only in relation to the nutritive value of all the other classes.

What foods are particularly rich in starch and sugar? When we speak of a starchy food we naturally think of the potato, which consists almost entirely of starch. It is true that the potato contains a small quantity of protein, a noticeable quantity of mineral substances, and a slight trace of oil. But all these things together form only two or three per cent of the weight of the potato, while the starch, including the small amount of sugar combined with it, forms from sixteen to eighteen per cent of the weight. The remainder is water, indigestible fiber, and mineral matter.

There are other foods with about the same content of starch as the potato. Among these are arrowroot and cassava. These products grow chiefly in tropical and semi-tropical regions, while the potato grows in temperate and north-temperate regions. Closely related to the potato are the so-called sweet potato and the yam. They also contain large quantities of

starch, together with considerable quantities of sugar.

Among the cereals, rice leads in starch-bearing properties, about eighty per cent of the content of rice being starch. Among the other cereals, Indian corn contains the largest amount of starch, and oats probably the smallest. But all of them contain considerable quantities. The content of starch in the cereals ranges from eighty per cent in rice to sixty-five per cent in oatmeal. Thus we see that the principal food product in cereals, so far as quantity is concerned, is starch.

There are many prepared foods in the market that are almost pure starch. Among these we find tapioca, cornstarch, cassava starch, and arrowroot. They are used extensively in preparing puddings and custards. As far as value is concerned, such foods are excellent for the production of heat and energy. They also promote the work of other food substances which aid in growth and in the restoration of tissue, though themselves of little value in that work.

The starch used in this country is produced principally from corn. In Europe the principal source of starch is the potato.

As we grow up our need for carbohydrates increases. This is a natural result of the greater

demands made on the system for heat and energy, furnished so abundantly by the carbohydrates. Thus the proportion of starch and sugar in the diet of the grown person should be much greater than the proportion found in milk, the ideal food for the infant and the child.

How can the carbohydrates aid in the digestion and assimilation of other foods? This is easily explained. The human body requires a varied diet, consisting of the five classes of food products already mentioned. This is a normal or natural requirement. The different organs of the human body can do their work best only when the food is of the normal quality and quantity. Any departure from this must necessarily be more or less injurious to the whole system.

The truth of this is evident in sickness, when it is necessary to alter the proportion of the different classes of foods in the diet so as to meet the conditions brought about by the disordered functions of the body. In some diseases it is advisable to restrict in great measure the quantity of carbohydrates (sugars and starches) in the food. If this restriction is carried to a certain degree, improvement takes place. On the other hand, if the carbohydrates are entirely taken away the effect may be, and usually is, decidedly harmful.

In building a house various materials are required — wood, lime, sand, stone, bricks, nails, iron and lead pipes, and furnaces. When the proper amount of materials is used the result is a house of good appearance and quality, suitable to live in, and comfortable. The result would be quite different if some materials were left out altogether and others were used in excessive quantities. If bricks were used without mortar, the house would soon fall to pieces. If an excess of wood were used, the house might take fire from the furnace, and so on with every single material used in the building of the house. This is an illustration of what happens when we eat too much of one kind of food and too little of another. Our foods should be so selected as to furnish all the materials needed, and all in the correct proportion for the proper development and growth of the body.

A STUDY OF FATS AND OILS

How are fats and oils used in body building? A considerable proportion of the foods we eat, both vegetable and animal, consists of fats and oils. The terms "fat" and "oil" apply to the same substance, although there is a distinct difference between the two. The term "fat" is applied to a solid oil, that is, an oil that is solid

at the temperature of the human body. The term "oil" is applied to a liquid fat, that is, a fat that is liquid at the temperature of the human body. Most vegetable fats are liquid and most animal fats are solid. Fats and oils are formed of essentially the same elements that exist in the carbohydrates.

What is the function of oils in nutrition? Aside from the flavor and taste of oils, which render foods in which they are present more palatable, the chief function of oil and fat in nutrition is to furnish heat and energy. Oil or fat affords a greater amount of heat than any other element of food.

Does an excess of fat in the tissues of the body shorten human life? This question cannot be answered definitely for any particular individual. So many things influence the length of human life that we cannot reach a satisfactory conclusion from the consideration of one thing alone. From studies made by

A boy of overweight and a boy properly proportioned

life-insurance men it has been estimated that if a man six feet tall weighs two hundred forty pounds, that is, fifty to seventy-five pounds more than he ought to weigh, we may expect that his life will be shortened by about four years. In some cases life would be shortened much more than this, and in other cases less.

What is the proper weight for grown persons of a given height? Various authors have constructed tables to show the proper weight for grown persons of a given height. The table below is from the *Laboratory Manual of Dietetics* by Dr. Rose, and is taken by her from the *Medical Record* of September 5, 1908:

SYMOND'S TABLE OF HEIGHT AND WEIGHT FOR MEN AT DIFFERENT AGES

(Based on 74,162 accepted applicants for life insurance)

Ages	15-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69
5 ft. 0 in. . .	120	125	128	131	133	134	134	134	131	
1 in. . .	122	126	129	131	134	136	138	138	134	
2 in. . .	124	128	131	133	136	138	138	138	137	
3 in. . .	127	131	134	136	139	141	141	141	140	140
4 in. . .	131	135	138	140	143	144	145	145	144	143
5 in. . .	134	138	141	143	146	147	149	149	148	147
6 in. . .	138	142	145	147	150	151	153	153	153	151
7 in. . .	142	147	150	152	155	156	158	158	158	156
8 in. . .	146	151	154	157	160	161	163	163	163	162
9 in. . .	150	155	159	162	165	166	167	168	168	168
10 in. . .	154	159	164	167	170	171	172	175	174	174
11 in. . .	159	164	169	173	175	177	177	180	180	180
6 ft. 0 in. . .	165	170	175	179	180	182	183	185	185	185
1 in. . .	170	177	181	185	186	189	188	189	189	189
2 in. . .	176	184	188	192	194	196	194	194	192	192
3 in. . .	181	190	195	200	203	204	201	198		

A STUDY OF THE BALANCED RATION

What is meant by a balanced ration? When building a house the builder always begins by making an estimate of the exact amount of every kind of material that will be needed. It would be very foolish for him to buy a great quantity of lumber and bricks and not buy any sand, mortar, and nails. So the wise builder calculates very carefully the quantity of each kind of material he must have in order to complete the building. As a result, when he begins his work he will have on hand just the right amount of all materials, even to the paints, varnishes, and trimmings. When his work is completed there will be very little building material left over.

At the same time the wise builder always tries to make certain that he has enough material. It would be better for him to have a little too much than not enough. Too little of any one kind of building material might be very costly, since the whole work would have to be delayed until the additional material could be bought. The house builder, in other words, secures his material in such quantities that he has enough of each and every kind, no matter how small or how large a quantity is necessary for the work that is to be done.

This principle holds good in supplying food

material for building up the body. We must endeavor to supply all the necessary materials, and in such quantities that there will be neither too much nor too little of any kind of material. We then have what is called a balanced ration. Yet, as in the case of the house builder, it is better to have a little too much than not enough of any single article. But the excess should be limited to the smallest possible amount, so that after the food is consumed and digestion is complete, very little waste will be left. In this way the needs of nutrition will be fully and economically satisfied.

How many kinds of materials are required for body building? It has been estimated that from twelve to fifteen different substances are required in the process of nutrition. Some of these things are similar in character to the paints, varnishes, decorations, and trimmings used in the building of a house. They may be left out without materially affecting the stability of the building, but neither the building nor the body would be quite complete or wholly presentable without these things.

If we select our common food products wisely, and in the correct proportions, we secure all the twelve to fifteen substances needed in nutrition. If we do not use wisdom and judgment in our selection, some essential substances will

probably be overlooked. Then the underfed body would be out of proportion and unstable.

What essential materials are commonly omitted? Among those commonly omitted are the mineral substances, so essential to the proper functioning of the body. In the preparation of our foods we usually reject the portions that contain much mineral substance, throwing away the peelings of apples, potatoes, and other vegetables, the bran of wheat, oats, and corn, and the germs of cereals, all rich in oil and organic phosphorus.

Usually the statement of a balanced ration contains no reference to the mineral constituents or the condiments. Yet to supply these substances, especially the minerals, is not only advisable but absolutely necessary. From one and one-half to two per cent of the total daily ration should consist of minerals, chiefly lime and phosphoric acid, with small quantities of potash, iron, soda, and magnesia. This requirement will be fulfilled if we eat foods no part of which has been discarded or greatly altered in the process of preparation.

Why should condiments be used? Having selected our food so as to secure the needed proportion of building minerals, we should next consider the question of condiments. The condiment used in largest quantities is salt. As in

the case of other useful substances, an excess of salt is injurious. No more salt should be used than is necessary for proper relish or seasoning purposes. Salt is used with some foods and not with others. It is used, almost universally, in bread, with vegetables and meats, and in butter and cheese. On the other hand, we do not usually put salt on fruits or in milk.

Other condiments, such as peppers, spices, and mustard, are commonly used with meats. Some are used with eggs and vegetables, especially in salads. These condiments are generally added in small quantities, otherwise the foods would be too strongly seasoned to suit the taste. Wood smoke, as you have already learned, is a condiment used in curing meats, such as ham and bacon. This condiment has a double purpose; it preserves the meat from infection by insects and bacteria and also adds a flavor that is well liked.

With the exception of salt, the condiments form a very small proportion of our food. Probably they do not exceed one twentieth or one fifteenth of one per cent of the total ration. The precaution with regard to the use of salt applies to the use of all condiments. They should all be used sparingly, just enough properly to stimulate the glands that supply the digestive ferments.

What should be the relative proportions of the chief food ingredients? Assuming that the mineral substances and condiments are present in the correct quantities, we must now consider the correct proportions of proteins, carbohydrates, and fats in a balanced ration. Experience as well as a careful study of the food supply of human beings under various conditions and in various countries has revealed the quantities in which these food substances should be present in order to make a balanced ration.

The standard ration of dry food for a man weighing one hundred fifty pounds is one pound and a half, or 640 grams. For a ration in which there is a generous proportion of protein, this 640 grams should consist of 120 grams of protein, 440 grams of carbohydrates (sugar and starch), and 80 grams of fat or oil. This is considered the proper proportion of ingredients in a well-balanced ration.

Specialists in the study of diets have a way of determining whether a ration is properly balanced. They multiply the number of grams of fat by two and one quarter. To this product they add the number of grams of carbohydrates. Then they divide this sum by the number of grams of protein. The quotient thus secured is called the *nutritive ratio*. Applying this rule to the standard ration of dry food given on

the preceding page, we get the following results:

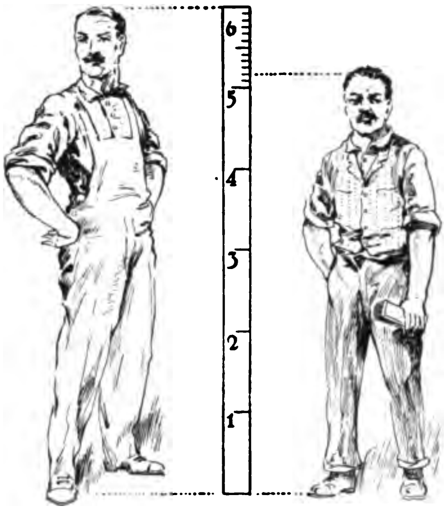
80 multiplied by 2¼ = 180
440 added to 180 = 620
620 divided by 120 = 5.2

This quotient (5.2) is the *standard nutritive ratio*. Assuming that there is the needed quantity of mineral matter and condiments in the ration, this quotient, 5.2, tells us that we have a standard ration in which the ingredients are present in the correct proportions. If we should decrease the amount of fat to 60 grams, and increase the carbohydrates to 450 grams and the protein to 130 grams, so as to make the same total, 640 grams, we would then have this problem:

60 multiplied by 2¼ = 135
450 added to 135 = 585
585 divided by 130 = 4.5

This quotient is less than the quotient (5.2) which has been taken as the standard nutritive ratio, and so we have what is called a "narrow ratio," meaning one with too much protein. On the other hand, if the quotient obtained by some other arrangement is more than 5.2, we may conclude that we have what is called a "wide ratio," or a ratio in which there is an excess of carbohydrates and fats. The wide ratio is best suited for men who work at hard physical labor. The narrow ratio is best for men engaged in less active physical labor, for those

who sit a good deal, and for those who do not wish to increase their weight. But any great variation from the standard nutritive ratio is more or less dangerous to health. Among those nations whose nutritive ratio commonly is wide, that is, if the nutritive ratio runs from 7 to 9, as in Spain, Greece, and Italy, the people are small in stature. If the ratio is narrow, as in the United States, Canada, and Australia, the people are large in stature.



An American and a Greek

How can people unacquainted with principles of nutrition select a ration of a standard nutritive ratio? Experience and the natural taste or instinct of the human being usually result in the selection of a diet that is well balanced. Persons in moderate circumstances who live in countries where food is abundant usually select a ration that approaches very closely the ideal, well-balanced ration.

The tendency to-day is toward a wider ration than is advisable, because many food substances extremely rich in protein, such as the outer layers and the germs of cereal grains, are rejected in preparing the cereals for food. As a result of the casting out of these materials we are eating larger quantities of starch and sugar than nature intended we should. Unfortunately, this excess of starch generally results from the exclusion of a large part of the protein, oil, and mineral substances which naturally are present in our foods.

Is it advisable to weigh the quantity of foods we eat? No. To sit down at the table with our thoughts occupied with the theories of eating, and then worry about how much of each kind of food we ought to eat, and what we ought not to eat, detracts greatly from the pleasure of eating, a sensation of great importance to digestion. We also interfere with digestion by concentrating our thoughts on subjects that are not likely to promote the digestive processes. We should be confident that those who provide us with food will provide what is best for us. Our natural tastes, corrected or supplemented by good manners, will prevent us from being gluttons, but still we should all know whether we are eating too little or too much of this or that food.

Moreover, ordinary experience in serving foods leads to a knowledge of how to regulate the quantity that each one should eat. The judicious mother always takes care that the child who is served first does not get too much and the others too little. The quantity each one receives, though not measured or weighed, is usually the amount each one ought to have. We should find it extremely annoying if at every meal we had to measure in a balance or measuring cup the exact amount of solid or liquid food we were to have. Apples and potatoes are not all the same size; but the large potato can be given to the large child, and the small potato to the small child, while the apple, if too large, can be divided between two of the children. The size of the slices of meat is determined by the person who wields the carving knife. He can adapt them to the age, size, and state of health of each individual. The milk is measured in glasses, each holding a certain definite quantity. Coffee and tea are not served to children, or at least should not be.

Is there any great danger from eating without weighing or measuring the food? Only under certain circumstances is there any very grave danger from eating without weighing or measuring food. If a child is very hungry he is

likely to ask for more of the food that is served first in the course of the meal than he ought to have. As a rule, good manners at the table correct this tendency. It is not good manners to ask for a second helping except under special conditions. In well-regulated families there is very little danger of overeating.

Weighing bread

What is a good rule to observe when eating? A good rule, if it can be conveniently followed, is to eat only one thing at a time. If we like a food for its taste and flavor there is no reason for depriving ourselves of that taste and flavor by eating it together with some other article of food. If we like the taste of meat, why do we want to mix it with that of potatoes? If we like bread, why should we destroy its taste by eating it with sirup? The French, who are recognized as authorities on foods and cooking,

eat their vegetables apart from their meats.

Fish especially is one of the foods that should never be eaten with anything else except the condiments that are usually used with such foods. No food so effectually destroys the character and flavor of other foods eaten with it as fish. Even the customary potato served with fish would better be omitted. Not only should no other article of food be eaten with fish, but the knives and forks used and the plates on which it was served should be removed and not used for any other food.

Fowl as well as fish, though perhaps in less degree, is better eaten alone. We are accustomed to eat cranberry sauce with turkey. As a matter of fact, turkey tastes much better without cranberry sauce. This sauce, if eaten at all, should be eaten as dessert. All fowls are commonly served with "stuffing," that is, a dressing made chiefly of bread crumbs seasoned with condiments and placed inside the turkey and roasted with it. The turkey would really taste better without it. A gravy is often served made from the juice which drips from the fowl while it is roasting. There may be some excuse for this, because the flavor of the gravy is derived from the fowl itself, but you will get the most enjoyment out of fowl by eating it alone. This is true of all meats.

Pork, especially fresh pork, is commonly served with apple sauce. There seems to be no special reason for this except custom. Apple sauce is an excellent food, but it is better as a dessert, or a dish to be eaten by itself, than as an accompaniment for pork. Vegetables also serve the best purpose as foods when eaten alone.

There are some articles which are so closely associated with each other that they are hardly to be considered as separate foods. I refer to the use of butter on bread or potatoes and the use of sirup and butter on hot cakes. In such cases the butter and the sirup supplement the various elements in the foods to which they are added.

The next time you sit down to eat, try eating the various articles of food separately. After eating a few meals in that way you will appreciate the value of the practice. You will be able to appreciate the real excellence of each food and to enjoy its taste to the utmost.

The point I wish to impress is that simplicity in diet, if there is variety enough, is one of the fundamental principles of scientific nutrition.

What relation has sociability to eating? To partake of food and drink together with companions is one of the enjoyable functions of social life. If a friend visits you, near the hour of the day

when food is commonly served, the simplest dictates of friendship lead you to invite him to participate in the meal. One of the chief functions of social life is the dinner to which friends are specially invited. At social gatherings of any kind — the meeting of a literary society,

Sociability promotes digestion

a musicale, a card party, or any similar gathering — it is customary to serve refreshments toward the close of the evening. The offering and receiving of food is a universal mark of friendship and good will.

The more pleasant the associations at the table, the more perfect are the workings of the digestive organs. Lightheartedness, pleasant conversation, and delightful companionship all

promote digestion. On the contrary, care and worry, disagreeable companions, and quarreling interfere with digestion. For this reason, when we come to the table cares of every kind should be put aside, all bickerings suppressed, and all trouble as far as possible forgotten.

XXVI. The Digestive Organs

THE TEETH AND THEIR USES

Why do we chew our food? To be properly digested, food must be reduced to very small particles. Liquids of course require no chewing, nor do such foods as soft puddings or mashed vegetables, except enough to separate them into smaller quantities. Solid foods must be reduced mechanically to fine particles; in other words, they must be ground.

The action of the teeth and the jaws is similar to the old-fashioned process of milling. In the old-fashioned method of grinding grain between an upper and a lower millstone only one of the stones moves; in chewing, only one of the jaws moves. In milling, however, it is usually the upper stone that moves, while in chewing it is the lower "stone."

Does the lower jaw move in more than one direction? Yes, the lower jaw has two distinct motions: first, the motion up and down, by means of which the food is cut into pieces; and second, the motion from side to side, by means of which the food is ground between the surfaces of the teeth.

Do the teeth in different parts of the mouth have different functions? Yes. The front teeth are

useful particularly in cutting the food into small pieces. They are, in other words, the cutting or incising teeth, and so are called *incisors*. By means of the front teeth we cut off a piece of food as large as we desire, and then reduce it to smaller subdivisions. The back teeth are called *molars*, derived from a Latin word meaning "to grind." When we cut off a piece of food with our front teeth the motion of the lower jaw is straight up and down. Thereafter, when the food is placed between the molars, the motion is up and down and also sidewise, so as to both cut and grind the food.

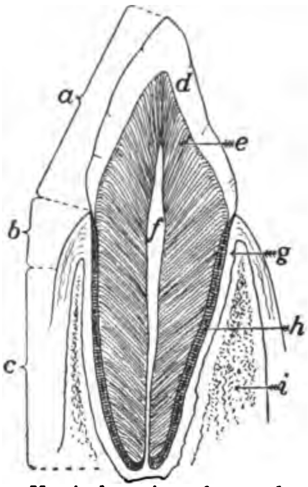
What are temporary teeth? At birth human beings have no teeth. It is said that Richard III of England had teeth when he was born, but the truth of the story is doubtful. If the story is true his case is a rare exception. The infant has no need for teeth. The only food he should have is milk, and milk, we know, requires no *mastication* or chewing. At about the fifth or sixth month the first of the temporary teeth appear. These are the incisors or front teeth. Usually four of them come out at about the same time, two in the upper jaw and two in the lower. Other teeth appear from time to time until, at the age of one year, the infant usually has eight teeth, four above and four below.

The total number of temporary teeth that appear in a child's mouth is twenty: four incisors, two *canine* or dog teeth, and four molars appear in the upper jaw and the same number in the lower jaw. The first temporary molar teeth usually appear from the twelfth to the fourteenth month, the temporary canine teeth from the fourteenth to the twentieth month, and the temporary back molars from the eighteenth to the thirtieth month.

The child begins to lose these teeth, which are called the milk teeth, from the fifth to the seventh year. At the same time the permanent molars back of the temporary begin to show. By the eighth or ninth year the temporary teeth are nearly all gone, and by the fifteenth to the seventeenth year most of the permanent teeth have appeared, with the exception of those farthest back in the mouth, which are called *wisdom* teeth. Sometimes these teeth do not appear until after the age of twenty-one.

Composition of the teeth. That part of the tooth projecting outside the gum is called the *crown* and is covered with a hard, flinty substance called the *enamel*. Below the gum there is no enamel, but the tooth is covered with a hard, bony substance called *cement*. Inside of the enamel and the cement is the tooth substance itself, the *dentine* as it is called. In the center

of the dentine is a cavity filled with the soft substance in which are the nerves and the blood vessels of the tooth.



Vertical section of a tooth
a, crown; *b*, neck; *c*, root; *d*, enamel; *e*, dentine; *f*, pulp cavity; *g*, gum; *h*, cement; *i*, jaw bone

The dentine or ivory of the tooth is practically of the same structure as the bones of the body, only it is much harder. It consists of about twenty-eight parts of organic matter, containing nitrogen, and seventy-two parts of mineral matter, consisting chiefly of phosphate of lime and carbonate of lime, with a little phosphate of magnesia and usually a trace of fluoride of calcium.

The enamel, or hard outer surface of a tooth, consists of about ninety-six per cent of mineral matters, of which phosphate of lime is the most abundant, with traces of fluoride of lime, carbonate of lime, and phosphate of magnesia.

The teeth are set into little holes or sockets in the jaw bones. That part of the tooth resting in these sockets is called the *root*. The front teeth have only a single root, while the side teeth have two roots and the back teeth, or molars, usually have three roots. These

roots extend into the bony structure of the jaws, holding the teeth in place with great firmness, so that they may do their work as millstones without danger of becoming loose. The part between the crown of the tooth and the root is called the *neck* of the tooth. This part is covered by the gum.

What does "cutting the teeth" mean? The term "cutting the teeth" is applied to the process which takes place when the teeth *erupt* or come through,— that is, when they first show through the gum. This process really is cutting the gum and not cutting the teeth. In the infant the gum is closed; that is, there is no opening through which the teeth can come. When the teeth erupt they must push their way through the gum. Though this is a natural process, the tooth growing very slowly and the gum gradually disappearing in the path of the growing tooth, this process is attended with tenderness and pain, and is often the cause of considerable irritation of the digestive organs.

"Teething" is a process which mothers look forward to with anxiety, especially if the process takes place during hot weather. Children that are born in the late spring or early summer have the advantage over those born in the middle of winter; since their first temporary teeth appear in cold weather and so cause less danger and

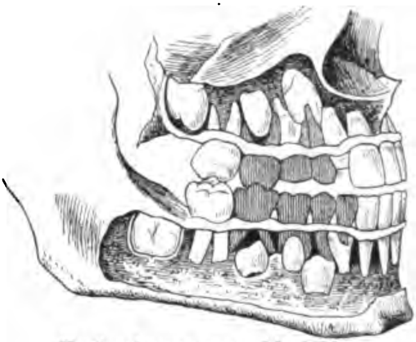
disturbance than in the case of children whose teeth come during the summer.

When the teething process begins it is customary to give the child some soft elastic substance on which to bite. The light rubber animals so commonly used as toys are excellent for this purpose, but they should be pasteurized, that is, heated for twenty minutes every day in water at a temperature of at least one hundred sixty degrees. This process makes the rubber safe for the child to use, and does not injure the texture of the rubber.

But they should not be permitted to do this for more than a very few days. Infants who are constantly putting such objects into their mouths, or who suck their thumbs, may introduce disease germs and are likely to have deformed mouths, projecting teeth, and distorted nostrils. These things may lead to mouth breathing. The tissues of the infant's mouth are very soft and yielding. That is why sucking the thumb may cause serious deformities.

What care should be taken of temporary teeth? The temporary teeth require as much care as the permanent teeth. They are extremely important to the health of the child from infancy to the age when the permanent teeth appear. This total period covers several years and

during that time the child must depend on his temporary teeth for chewing. These years are of the greatest importance to the child, since they offer the best opportunity to establish good health and build up a strong and efficient body.



Teeth of seven-year-old child. The milk teeth are shaded

Although imperfect temporary teeth are a menace to the health of the child, a great many people are unaware of it. If a temporary tooth starts to decay the parent is usually consoled with the thought, "Very well, let it go. The new tooth will soon take its place." Such indifference is extremely dangerous. If the temporary tooth is lost before its time, there is danger that the permanent tooth which follows it will not develop properly. The germs of the permanent teeth develop early, so, if a temporary tooth is lost before its time, the germ of the permanent tooth will seek to occupy the vacant space. The germs of the permanent teeth on either side may also seek to grow into this open socket.

For these reasons every precaution should be

taken to develop and preserve good temporary teeth as well as good permanent teeth.

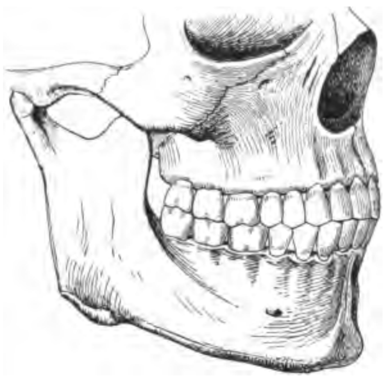
How may good teeth be developed? Good health and the right kind of food are necessary for the development of good temporary and permanent teeth. The food should be rich in bone-building and tooth-building material. For this reason the diet of the child should contain plenty of mineral substances, particularly lime and phosphoric acid. Milk is an ideal diet for the child, since it contains lime and phosphoric acid in the proportions needed to build up the bones and the teeth.

When the child begins to eat solid foods and take less milk, it should eat the foods containing the necessary amount of mineral substances. The minerals, as we have already learned, are most abundant in the outer coverings of cereals, vegetables, and fruits. So when we throw away the skins of vegetables and fruits, and the fibrous coverings of the cereals, we deprive ourselves of mineral foods that are necessary for the development of the teeth. Young children cannot very well eat the skins of fruits or of potatoes. But the coverings of cereals, if ground very fine, are suitable foods for them. By using the proper kind of millstones the outer coat of the grain is so ground that it easily gives up its mineral matters in

the digestive process. Children should therefore be fed liberally with bread made from the whole grain ground fine in the old-fashioned way. Modern mills using smooth steel rollers do not grind the bran but break it into large flakes. In this form the bran is not suitable for digestion by children or even by grown people.

How do bad teeth endanger the health? Many dangers threaten the health of those who have poor teeth. Children, especially, are in danger. Children with poor teeth cannot chew their food properly. The mechanical separation of the food into small particles can be accomplished only when the teeth are in good working order.

Moreover, it is of great importance that chewing should be done so thoroughly as to mix the saliva with every particle of food. The saliva aids the process of swallowing and provides the additional moisture necessary to prepare the chewed mass for digestive purposes.



A good set of teeth

It also contains the ferment *ptyalin* (*enzyme*), a substance which rapidly changes starch particles

in the food into sugar and *dextrin.* If the process of chewing is continued the saliva will convert a great part of the starch into sugar (*maltose*) and dextrin.

What other dangers result from bad teeth? Decaying teeth are receptacles for all kinds of injurious bacteria. This is true especially if the decay extends down into the roots. If pus be formed it may easily be absorbed into the blood, causing very serious results.

It is almost impossible to keep a decaying tooth clean. It is hard to get at the decayed spot, which is often located between the teeth or concealed just below the gum. Even if we could reach the spot it would be difficult to remove the bacteria from it.

Thus every decaying tooth, and every tooth that is so deformed that it cannot perform its functions of cutting or grinding food, is very dangerous to health.

How may we avoid these dangers? We must first discover the nature of the dental trouble. Sometimes the teeth are irregular and uneven. Very often the upper teeth project out of place. In early life such teeth may gradually be brought back into place by a skillful dentist. Very often two growing teeth are trying to occupy the same position. If it is too late in life to bring them back into place, one of them, the one that

is farthest out of place, should be extracted, leaving the remaining tooth to be brought into its proper position.

Unfortunately the cost of bringing badly placed teeth into the proper position is too great for persons in ordinary circumstances. For this reason it is highly important for the parent to make sure that the temporary teeth are properly preserved, and so guard against deformities.

In nearly all cases it is possible to save the teeth from early decay by inspection, cleanliness, and prompt attention to the first signs of decay. Careful attention to this matter is the duty of every parent. It is also the duty of every young person to do what he can to preserve his health.

What is the purpose of dental inspection in the public schools? The purpose of dental inspection in the public schools is to discover the condition of each child's teeth and the nature of the tooth trouble, if there is any. In order that the school may best serve its purpose — that the children may learn their lessons, obey their teachers, and remain in good health — the teeth of every child must be inspected and dental troubles corrected. The dental inspector furnishes a card showing the character of the disease or deformity. The child brings the card to the

parent, who then takes it to the family dentist. By means of this card the dentist will know at once where to look for the trouble.

Parents who are not able to pay for such services can go to the public dental clinic, which provides free treatment. Such clinics are of the greatest importance to a community, and no village or city should be without one.

Many children in the public schools have

A school dentist inspecting a child's teeth

never had their mouths examined by a dentist. In many cases the parents, even, do not examine their children's mouths and do not know their condition. Experience has shown that when bad teeth are remedied, great improvement takes place in scholarship, deportment, and health. It is almost useless to try to teach children whose teeth are bad. Rather than

try to teach them it would be better to take a determined step to save their teeth. If necessary, the teaching should be discontinued until the teeth are saved. A child can learn his lessons next year, but he cannot regain next year the teeth he loses this year.

Careful dental inspection and prompt attention to the faults which it reveals, together with public support of a clinic for the children whose parents are unable to pay for such work, are of prime importance to the welfare of every community and the success of every school.

THE SALIVARY GLANDS AND THEIR FUNCTION

What are the salivary glands? The salivary glands are organs adjacent to the mouth, whose function it is to gather the saliva and pour it into the mouth through ducts or tubes provided for that purpose. The saliva keeps the membranes of the mouth constantly moist and is especially abundant during the time of eating. The largest of the salivary glands lie near the ear. These are called the *parotid* glands, the word parotid meaning "near the ear." There are two of these glands, one on each side. In the grown person they vary from one half ounce to an ounce in weight. The ducts through which the saliva enters the mouth are about two inches and a half in length.

The salivary glands next in importance are situated under the lower jaw in the upper part of the neck and are known as the *submaxillary* glands. There are also two of these, one on each side. The third pair of salivary glands is situated under the tongue, and for this reason they are called the *sublingual* glands.

The salivary glands are abundantly supplied with arteries, veins, and nerves. They are active at all times, but become very active when we are hungry, when we smell a good dinner, or when we sit down before an appetizing meal and look at all the good things. You have all heard of the mouth "watering." This means that the salivary glands are pouring a large amount of saliva into the mouth in anticipation of the good food which the sense of smell or of sight has discovered and reported.

The gland under the tongue may be regarded as one gland, although, since it is situated on both sides of the median or middle line of the tongue, it is practically two separate glands. The gland under the tongue has a large number of ducts for the discharge of saliva, varying from eight to twenty, each with a separate opening into the mouth.

Constant chewing, especially of a substance that tastes good, will cause the glands to discharge large quantities of saliva. But such

continuous activity of the glands cannot be regarded as desirable. The function of the salivary glands should not be wasted by chewing gum or any substance demanding constant and continued activity. Abused in this way, the glands become overworked and worn out, and so become unfitted to play their part in aiding the processes of swallowing and of digestion.

A STUDY OF SWALLOWING

How do we swallow our food? When the food has been well masticated and thoroughly mixed with saliva, the natural tendency is to pass it back toward the base of the tongue in the form of a *bolus* or ball. From the base of the tongue it passes into the opening of the esophagus, the tube situated behind the windpipe and leading from the mouth to the stomach, and is then swallowed. The process of swallowing cannot be controlled by the will. It is involuntary. The fibers of the esophagus contract involuntarily and force the food into the stomach. You can keep the food from getting into the esophagus, but once it is there you cannot by any force of the will prevent yourself from swallowing it.

If the food, instead of going into the esophagus, should enter the passage to the lungs, violent protests would result, in the form of

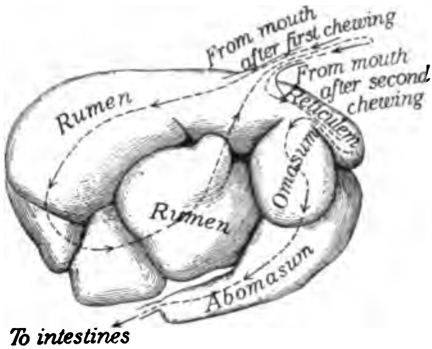
coughing. This is the means nature takes to drive the unwelcome substance away. Should the food become fixed or fastened in the opening of the *trachea* (windpipe) the supply of air would be cut off from the lungs and death would follow.

Instead of swallowing, does the esophagus ever work the other way? Yes, in certain cases of sickness nature often reverses the act of swallowing and the food is forced up through the esophagus and out into the mouth. This is called vomiting. That process is also involuntary. We cannot prevent vomiting by means of the will. But we can aid it by irritating or tickling the throat, by taking medicine which produces nausea or irritation of the stomach, or by drinking warm water, especially if it contains a little salt. Thus by mechanical means or by medicines we may aid the stomach in ridding itself of substances which it cannot properly digest. The fibers of the esophagus reverse the action of swallowing and drive the food out again.

Ruminant animals,—those that chew the cud, like the cow and the sheep,—are provided with a special stomach. This stomach receives the food in the form of boluses produced by the process of chewing. When this stomach is full and the animal stops eating, these boluses one by one are sent back into the mouth, where

they go through a second process of chewing. When swallowed the second time, the bolus passes into a second stomach.

The human being is not provided with any apparatus of this kind. We must be content, therefore, with one chewing and one swallowing.



Stomach of a cow, showing course of food

Is it desirable to aid the process of swallowing by using liquids while chewing? This question of the use of liquids while chewing has been the subject of much discussion. The best authorities generally oppose the use of liquids while chewing. They claim that such liquids diminish the activity of the salivary glands so that a decreased quantity of saliva is sent into the mouth. If we do not take liquids, and if we chew our food a little longer, greater quantities of saliva will be incorporated with the food. This is especially desirable when eating starchy foods. When eating lean meats, eggs, and foods of that kind, it makes little difference whether the liquid required for the process of swallowing is provided by the salivary glands or by drinking.

It is a common practice to drink while eating, and since most people are reasonably well it is doubtful whether it is harmful to drink small quantities of liquids while partaking of food. But it is far better to do the chewing and swallowing first, and then, if more liquid is needed in the stomach, to drink afterward. If the liquid used is a food, as in the case of milk, the objections to drinking during eating are largely removed.

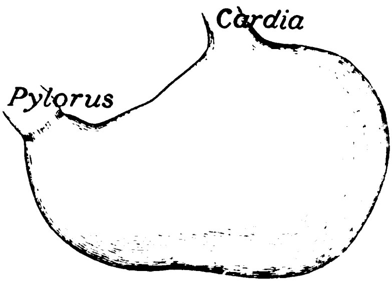
We have already called attention to the desirability of eating only one kind of food at a time. The same principle applies here. Swallow your food first; then drink afterward. But we must not forget that the food in the stomach must have a certain quantity of liquid mixed with it in order that it may be readily acted upon by the digestive ferments of the stomach.

Good sense and good advice will lead children to take the proper amount of liquids during the meal. Coffee, tea, cocoa, chocolate, and beer should not be a part of the child's diet.

THE FUNCTION OF THE STOMACH IN DIGESTION

What is the stomach? If you follow the Detroit River as it flows south from Detroit you will soon come to where the river widens into a lake. If you follow that lake eastward two hundred

miles or more you will find that it contracts and again becomes a river, which rushes over Niagara Falls. Lake Erie, therefore, may be regarded as an expansion in a river. The stomach bears much the same relation to the esophagus, or gullet, that Lake Erie bears to the Detroit River. It is an enlargement of the esophagus and has a shape somewhat similar to that of Lake Erie. The stomach is situated in the upper part of the abdominal cavity and is separated from the lungs and the heart by a muscular partition called the *diaphragm*.

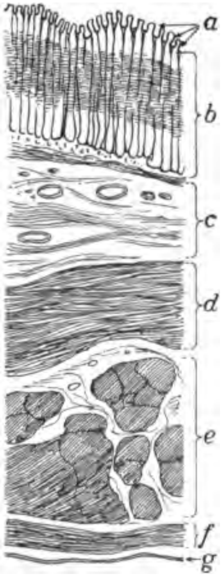


Human stomach showing cardia and pylorus

The esophagus enters the stomach at a point near the heart, and for that reason the opening is called the *cardiac orifice*. The exit from the stomach, corresponding to the Niagara River, is called the *pylorus*.

The size of the stomach varies with the size and age of the individual. In the adult of ordinary size the stomach is about twelve inches in length and four inches in diameter at the greatest point. Its weight, empty, is about five ounces. In the infant the stomach is very small, and when distended is not able to hold

much more than half a pint. In the adult the stomach can be distended considerably and can hold large quantities of liquid and semi-liquid material.



Enlarged section of the stomach wall

a, gland mouths; *b*, mucous membrane; *c*, submucosa; *d*, oblique muscular fibers; *e*, circular muscular fibers; *f*, longitudinal muscular fibers; *g*, peritoneum.

The inner coating of the walls of the stomach is a mucous membrane similar in character to the membrane inside the mouth and the esophagus. The walls of the stomach consist of four layers of muscular fibers that are capable of automatic movements, that is, movements not under the control of the will. It is by means of these automatic movements of the stomach, and the movement of the esophagus in swallowing, that the contents of the stomach are kept well mixed and gradually forced toward the pyloric opening, where they enter the small intestine.

Because fowls have no teeth, they are provided with a very strong and muscular stomach. Chickens and ducks eat large quantities of sand and gravel with their food, and these form millstones between which the solid grains,

like wheat and corn, are ground into particles.

The movements of the human stomach are very vigorous and they greatly assist the digestive processes. While these movements are involuntary, they are influenced more or less by the state of mind of the individual. Attention has already been called to the fact that pleasant conversation, agreeable companionship, and attractive surroundings promote digestion. In other words, these things stimulate the movements of the stomach and the activity of the glands which secrete the digestive ferments. On the other hand, anger, deep sorrow, or unpleasant surroundings interfere more or less with these movements, thus retarding or deranging the process of digestion. Sometimes the stomach is distended too much by overeating or drinking. This unnatural pressure tends to paralyze the muscular movements, and so interferes with digestion.

If we could see the stomach during the normal process of digestion we should find it going through all kinds of contortions, as if in pain. The fact of the matter is that these are normal convolutions performed in peace and comfort in the course of preparing the food for use in the body.

In the mucous membrane in the stomach are the openings of the glands which secrete the

digestive ferments. When examined with a magnifying glass the mucous membrane looks much like honeycomb, for there are many shallow depressions of small dimensions. In these are the openings through which the digestive ferments enter the stomach.

What digestive ferments are most active in the stomach? There are two principal digestive ferments in the stomach. In children's stomachs a ferment is secreted which has the power of coagulating or curdling milk. This ferment is known as *rennet.* If milk remained in a perfectly liquid state in the stomach it probably would be expelled before it could be properly digested. Nature avoids this by converting the liquid milk into a mass of semi-solid flakes. In this form the milk is retained in the stomach until the flakes are dissolved. In the manufacture of cheese, rennet extracted from pigs' stomachs is used to curdle the milk.

As we grow older, the amount of rennet which is secreted decreases. Nevertheless, as soon as we drink milk, and some of us drink milk all our lives, the rennet plays an important part as a digestive ferment. The other important digestive ferment is *pepsin,* a ferment that is active in the digestion of protein. The protein is converted by the pepsin into a substance called *peptone.* If we heat the white

of an egg it hardens. If we now add pepsin and a little hydrochloric acid to this substance, and keep the mixture at the same temperature as that of the body, namely, ninety-eight and a half degrees, we shall see the white substance gradually dissolve. Soon all of it seems to have passed into solution, and we know that the protein in the white of the egg has been converted into soluble peptone.

Converting the white of an egg into soluble peptone

This is the first step in the digestion of protein as it takes place in the stomach. It is also the principal digestive function of the stomach. Though the food in the stomach may consist of a mixture of proteins, starches, sugars, and fats, practically the only element of the food that undergoes extensive digestion in the stomach is the protein.

The saliva, as we have already learned, begins to act upon starch as soon as it enters the mouth. The starch then passes into the stomach, where an acid secretion, known as hydrochloric acid,

gradually brings the activity of the saliva to a stop. This is because the saliva is *alkaline*, that is, it contains lime, magnesia, and sodium. These substances cannot act as a ferment when they come in contact with acids. But it is probable that before the activity of the saliva has been brought completely to a stop by the acid, most of the starch has been converted into sugar and dextrin.

The ordinary fats are not digested in the stomach, but they are probably churned up so that their mixture with other food may be more complete.

How long does the food remain in the stomach? The length of time the food remains in the stomach varies with the character of the food, the activity of the digestive process, and the work the person is engaged in doing. If one is at rest or only moderately active immediately after eating, the process of digestion goes on at a faster rate than if one is engaged in very violent physical or mental exercise. Substances like milk and meat are digested with comparative rapidity. Large quantities of starch and fats mixed with other foods retard the process of digestion.

Under ordinary circumstances the stomach is practically empty in from three to four hours after eating. In infants, who get nothing but

milk, the digestive process goes on more rapidly; after two and a half hours the infant's stomach is practically empty. For this reason infants and children should be fed more frequently than grown people. Infants may be given six or seven meals a day. Children from two to five years of age may be given four or five meals a day. Above the age of five we can usually get along with three meals, and grown persons not engaged in hard labor can get along very well with two meals.

How do the digestive ferments act? No one can tell how the digestive ferments act. The digestive ferments themselves cannot be digested. They are little workmen who tear down the structure of the food. Just how they do their work is a matter of theory and imagination only. We can trace the process of digestion but we cannot explain just how it is done. We know it can be accomplished only by means of these ferments, that the ferments take an active part in the process, and that they are not living beings but belong to a class of substances known as *activators* or *excitors*.

What is the character of the acid in the stomach? The acid in the stomach is chiefly hydrochloric or muriatic acid. Hydrochloric acid, when united with sodium, forms common salt. The

source of the hydrochloric acid in the stomach is doubtless common salt, which is split up by certain activators into its two elements, hydrochloric acid and sodium.

How much hydrochloric acid does the stomach contain? After the stomach is emptied of food, and before it receives a new supply, it probably contains but little hydrochloric acid. But the healthy stomach is never free from the acid. The glands that secrete hydrochloric acid are somewhat similar to those that secrete the pepsin and the rennet. They are not energetically active except when excited by the proper food.

You have already been told how the salivary glands are excited or stirred to action, especially at the thought or sight or odor of good food. All these sensations cause a flow of saliva and are purely mental. The excitation of the glands of the stomach, however, is caused by certain properties of the foods themselves.

Among the foods that are most active in exciting the glands of the stomach are meats and meat juices. Among those that are less active are bread and the cereals. Experiments have shown that if bread is introduced into the stomach of a dog in such a way as not to suggest the idea of food, the digestive fluids of the stomach will not be secreted and the protein in the bread will remain undigested for a long time.

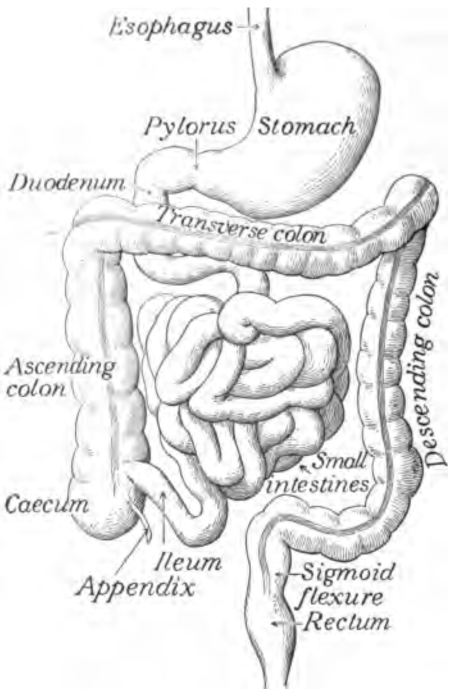
Some foods, therefore, have more effective properties than others in directly exciting the flow of the digestive fluids. The secretion of hydrochloric acid in the stomach is due to the the same kind of excitation as that which produces the flow of the digestive ferments, pepsin and rennet. The acid first secreted after eating is absorbed by combining with the food. Gradually the acid permeates the food, and brings to a stop the action of the saliva on the starch in the food. After an hour or two the amount of acid in the stomach increases and continues to increase until near the end of digestion, when the flow of hydrochloric acid begins to stop.

The maximum quantity of hydrochloric acid in the stomach is perhaps never more than one half of one per cent of the total contents of the stomach.

What is heartburn? Heartburn is the result of too much acid in the stomach. In some forms of indigestion, such as dyspepsia, usually caused by overeating or eating certain kinds of foods, the acid glands inject a greater quantity of acid into the stomach than is required for digestion. This acid causes disturbance and pain. Since the stomach is placed near the heart, the trouble was thought to be in the heart and hence was called heartburn.

The proper remedy for heartburn is to avoid

eating too much, and especially to avoid eating foods that are known to cause the secretion of too much acid. Highly spiced foods, such as fruitcake, plum pudding, and mince pie, are very apt to affect some people in that way. Alcohol in all forms, especially beer or wine, also has that effect on many people. Such articles should be avoided in order to bring about a permanent cure.



The intestines

The exit of food from the stomach. Food passes from the stomach into the small intestine through the opening known as the *pylorus*. At the pylorus there is a kind of fold that acts more or less as a valve. This fold prevents the liquid portions of the food from passing too

rapidly from the stomach into the small intestine.

What is the small intestine? The small intestine is a channel quite unlike that of a river in that the farther it is away from its beginning at the pylorus the smaller it becomes. The reason for this is clear. As the food enters the small intestine, and the process of digestion continues, the food is gradually absorbed and hence decreases in quantity on its way through the small intestine.

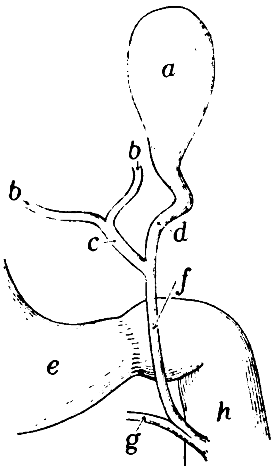
The first part of the small intestine is about as long as the breadth of twelve fingers, and so is called the *duodenum*, from a Latin word meaning "twelve each." It is a foot long. At first it passes slightly upward from the stomach, then it curves downward, approaching the spinal column. There is no very distinct mark to show the end of the duodenum and the beginning of the next portion of the intestine, which is called the *jejunum*.

The jejunum gets its name from a Latin word meaning "empty," because it was always found to be empty after death. The jejunum is about eight feet long, that is, about two fifths of the length of the small intestine. It is laid in convolutions or folds, so that it may lie within the cavity of the abdomen.

The third portion of the small intestine, the *ileum*, has its name from the Greek word

meaning "to twist." It is distinguished by its numerous convolutions or coils. It is practically twelve feet long, about three fifths of the whole length of the small intestine. In a grown person of ordinary size the small intestine is about twenty feet long.

What is the function of the small intestine? As we have learned, the principal digestive function of the stomach is to reduce the protein materials in the food to the form of peptone. The function of the saliva is to start the digestion of the carbohydrates, starch and sugar. The completion of the digestive process now takes place in the small intestine.



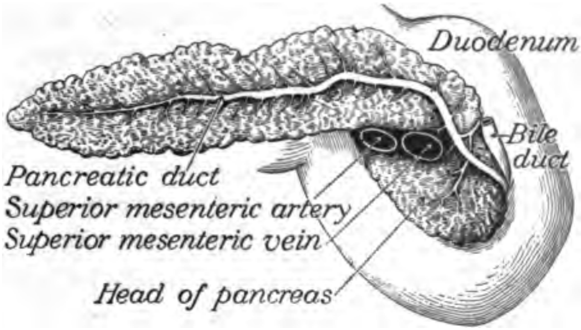
The gall bladder

a, gall bladder; *b*, right and left ducts from liver; *c*, hepatic duct; *d*, cystic duct; *e*, stomach; *f*, common bile-duct; *g*, pancreatic duct; *h*, duodenum

In the duodenum the food is mixed with two important digestive secretions. One of these is the *bile* or gall. This secretion from the liver collects in a pouch called the *gall bladder* and is transmitted through a tube opening into the duodenum about halfway of its length. Next in importance are the secretions from a gland called the *pancreas*. These secretions also enter the duodenum.

The bile and the secretions from the pancreas, together with the natural secretions in the walls of the duodenum, are alkaline, and so overcome the acidity of the food as it passes through the duodenum. The food thus first becomes *neutral*, that is, neither acid nor alkaline; later it becomes alkaline because of the increased amount of alkaline fluid in the intestine.

What is the pancreas? The pancreas is a long, narrow gland lying in the upper part of the



The pancreas

abdominal cavity near the spleen and the duodenum. It is provided with a tube or duct by means of which its secretion, after combining with the secretion from the bile, is poured into the duodenum not very far beyond the pylorus. The daily quantity of secretions of the pancreatic juice in a man of average size ranges from a little over a pint to almost a quart.

One of the important digestive ferments in the pancreatic juice is *diastase* or *amylase*. This has the same property as *ptyalin*, the active ferment in saliva, which we know converts starch into sugar and dextrin. Another important ferment from the pancreas is *trypsin*. This ferment acts on the peptone, reducing it to lower forms of combination known as *amino* acids. Thus trypsin is closely related to pepsin. The pepsin begins the work of digesting protein and the trypsin completes it. The third important ferment in the pancreatic secretion is that which converts fat into glycerin and free acid. It is known as *lipase* or *steapsin*. These ferments continue to act on the food as it passes through the small intestine.

Thus it is seen that three separate kinds of digestion take place in the small intestine. The peptones are reduced to lower forms of combination; the carbohydrates (starch and sugar) are reduced to maltose (malt sugar), dextrose (right hand sugar), and levulose (left hand sugar); the fat is reduced to glycerin and free fatty acids. All of these products are soluble or suspendable in a fluid secretion present in the intestine and thus pass in a liquid state through the absorbent vessels which line the walls of the small intestine. They then gather in a common stream that is poured into

the blood and so are carried to every part of the body.

What is bile? Bile or gall is a secretion of the liver. It has a double purpose. In one sense it is a waste product, separated by the liver from the blood for the purpose of eliminating it from the body. In the second place it has important digestive functions and in many ways performs the same functions as pepsin in the stomach and the secretions of the pancreas.

The formation of bile in the liver is probably a continuous process. But it is not poured continuously into the small intestine. In man and in some animals it is stored up in a little sack called the gall bladder. From the gall bladder the bile is poured into the duodenum through a duct which unites with the duct leading from the pancreas to the duodenum.

A STUDY OF THE LARGE INTESTINE

What are the functions of the large intestine? When the food has passed through the small intestine, which is approximately twenty feet long, or three fourths of the whole length of the alimentary canal, it enters the large intestine, which may be described as a secondary stomach. A comparison has been made between the stomach and Lake Erie. The large intestine in like manner may be compared to Lake Ontario.

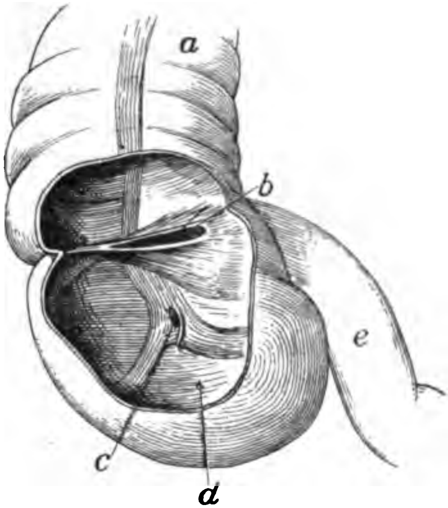
The end of the small intestine is smaller than the beginning. This, we have learned, is because of the fact that the food is gradually digested and absorbed into the body as it passes through the small intestine, and so as the amount of food materials diminishes the size of the intestine or carrier diminishes.

The first part of the large intestine resembles a pouch, and is called the *caecum*. The opening from the small intestine into the caecum is guarded by two folds of membrane, known as the *ileo-caecal* valve.

The passage of the food in the process of digestion through the small intestine is quite rapid. The exact length of time varies with the character of the food eaten and the age and habits of the individual. As the digested food pours into the large intestine at the ileo-caecal valve the rate of progress is at once greatly reduced. It is evident, therefore, that the object of the large intestine is to receive the contents of the small intestine and hold them until a convenient time for their excretion. It is believed that very little digestion goes on in the large intestine.

In addition to the caecum, other parts of the large intestine are the *ascending colon*, so called because this part leads upward; the *transverse colon*, which crosses the abdominal cavity from

one side to the other; and the *descending colon*, the part which leads to the end of the intestinal tract, the *rectum*.



Colon, caecum, and ileum
a, ascending colon; *b*, ileo-caecal valve; *c*, orifice of appendix; *d*, caecum; *e*, ileum

The caecum receives from the small intestine not only the excess food but also any remaining enzymes, alkaline substances, and waste products that may be present. If there is any undigested food, the digestive ferments carried with it into the large intestine may continue their work for some time, though always with less and less activity.

While the walls of the small intestine are richly supplied with absorbing apparatus for conducting the digested food into the blood current, very little enters the body through them. The principal material absorbed in the large intestine is water. The contents of the intestine therefore become firmer and harder as they pass upward through the ascending colon,

across the body through the transverse colon, and down to the rectum through the descending colon. At this point the contents of the large intestine are called *feces*. The diameter of the large intestine is approximately from two to two and a half inches.

Are active organisms present in the large intestine? The contents of the large intestine favor the development of large numbers of very small organisms, known as *bacteria*. These bacteria are found under practically normal conditions and so their presence does not really indicate the use of the wrong kinds of food or improper methods of eating. They exist in such enormous numbers that a considerable part of the feces in the rectum may be made up of these small vegetable growths.

These bacteria act particularly on any remaining carbohydrate or protein matter in the contents of the large intestine. Especially interesting is the result of their activity on any protein that remains. This protein is broken down into products that are regarded as poisonous if they exist in excessive quantities or are retained in the body for an unusual length of time.

These products consist of both liquid, solid, and gaseous substances. The most important in regard to their effect on health are *indol*,

phenol, and *skatol*. Phenol is the chemical name of carbolic acid. Indol is related more or less closely to indigo. Skatol is distinguished by its bad odor. All these products, which are found normally in healthy persons, are regarded as dangerous to health if formed in too large quantities or kept too long in the body.

They pass into the blood to a large extent through the walls of the large intestine, and are finally separated from the blood by the kidneys and sent to the urine. When combined with sulphuric acid these substances, indol, phenol, and skatol, are easily separated from the blood. The quantity in which they are present in the urine is regarded as a measure of the bacterial activity which goes on in the large intestine. Physiologists have regarded these products of bacterial activity as the causes of old age and of death.

As we have already said, some people believe that by drinking large quantities of sour milk we may diminish the activity of the bacteria in the large intestine and thus prolong life. Although this theory has a great many eminent supporters, observation of the matter has not been extensive enough to accept it as wholly true. It is doubtless true that sour milk in good condition is a wholesome food, but it is not likely that by drinking large quantities of

sour milk we can each live to be a hundred years old.

After the feces have been retained in the large intestine for a varying period of time, they are voided from the body as the final step in the complete history of the food in its course through the body.

ABSORPTION OF FOODS

How do nutrients obtained by the process of digestion pass into the blood? It is not difficult to get a general idea of how absorption of the nutrients obtained by the process of digestion takes place. The whole alimentary canal, beginning with the mouth, is lined with what is known as the *mucous membrane*. This mucous membrane constantly secretes a fluid consisting mostly of water and containing a viscid, slippery substance. This fluid is called *mucus*. Usually the mucus is colorless but sometimes, when excreted in large quantities or if excreted from certain membranes, it is milky or even yellowish in color. Mucus is necessary to the proper activity of the whole digestive tract. Anything that interferes with the normal secretion of mucus tends to induce or promote disease.

We have already learned of other secretions that are poured through openings in the mucous membrane into the digestive canal, particularly

the digestive ferments provided by the salivary glands, the digestive glands in the stomach, the liver, and the pancreas. The mucous membrane, especially in the small intestine, is also supplied with an extensive system of absorbing vessels. It thus permits the passage of substances in both directions, the secretion of the digestive ferments and the mucus, and the absorption of the digested foods and water.

Are food products absorbed in the stomach? Though preliminary digestion takes place in the stomach, no considerable amount of food is absorbed there. On the other hand, certain substances that cannot be regarded as true foods are readily absorbed. The most important of these is alcohol. Water, which is so important to the digestive process, is not absorbed in any quantity through the walls of the stomach unless alcohol is present. Small quantities of certain sugars in our foods are probably absorbed, but it is doubtful whether this is true of any of the fats. Absorption through the walls of the stomach, therefore, is not an important function of that organ. Neither is such absorption of any great importance in relation to health.

How are foods absorbed in the small intestine? The great system of vessels provided for the absorption of food is distributed throughout

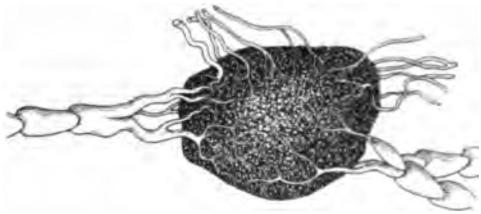
the mucous lining of the small intestine. Slender projections, known as *villi*, cover this lining. In these are spread *capillaries*, minute vessels which take up the products of the digestion of the carbohydrates and also of protein. These products are then conveyed in the blood stream through a tube known as the *portal vein* into the liver.

A portion of the sugar is retained in the blood and passes immediately from the liver to all parts of the body to be burned for the purpose of producing heat. The remainder is converted into *glycogen* (sugar producer) and stored away, to be given up little by little in the form of sugar as conditions may require.

It is important to keep a certain fixed amount of sugar in the blood at all times. It has been estimated that a thousand parts of blood carry only about fifteen parts of sugar. One of the chief functions of the liver is to receive the whole mass of carbohydrates (sugars) as they are digested, and distribute them in such quantities as to provide the blood with its normal amount of sugar.

After the fats have been digested in the small intestine they are taken up by a second system of absorbers, known as *lymphatics* or *lacteals*. These absorbers are also present in the villi. The fats are carried through them into the

thoracic duct and thence into the blood. The thoracic duct is a tube that receives all the



A lymphatic gland

little lymph carriers. It is like a river fed by a multitude of springs. It pours its contents into the blood stream through a big vein near the left shoulder. When the fats are absorbed they form a milky emulsion. For this reason the contents of the larger absorbing vessels become whitish in appearance when food containing a large quantity of fat is absorbed.

There is no doubt that a part of the digested protein is absorbed by the same vessels that take up the fat, and that it enters the circulation together with the fat. In fact, it is not improbable that neither system of absorbers is engaged exclusively in taking up a certain food product.

Do the various kinds of protein differ in the degree of absorption? Experience has shown that certain proteins, especially those contained in milk and eggs, and to a certain extent those found in meats, are more readily and completely absorbed than some others. It is believed that ninety-five

per cent or even more of the protein of milk, eggs, and meats, eaten in normal quantities by perfectly healthy individuals, is digested and absorbed.

The absorption of the protein contained in vegetables is not so great. The gluten of wheat, the zein of corn, or the *hordein* of barley, for instance, are not absorbed so completely as the casein in milk or lean parts in meat. The protein in bran, especially, is not absorbed in large quantities. The reason for this difference lies not so much in the nature of the protein itself as in the fact that the vegetable proteins are incrusted with a substance known as *cellulose* as well as with other substances that are difficult of digestion, and so protect the proteins more or less from the action of the digestive ferments.

While the greater part of our food is absorbed in the manner described, we should not forget that the mucous membrane may and probably does have a slightly absorbent effect throughout the whole course of the digestive tract, with the possible exception of the mouth and the esophagus.

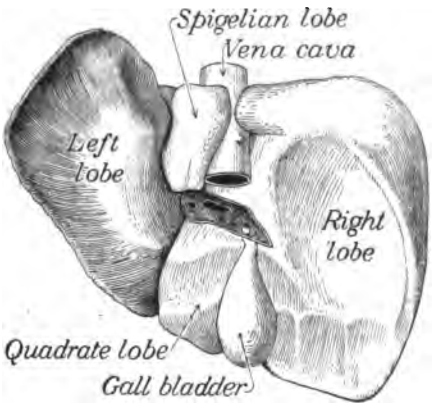
How are mineral substances absorbed? The mineral substances we eat are doubtless absorbed in the various ways in which the proteins, the carbohydrates, and the fats are absorbed. Common mineral substances (salt,

phosphates, lime) are not readily absorbed in the stomach unless they are present in large quantities, and it is not likely that common salt will be eaten by any one in very large quantities.

The use of condiments in our food has a stimulating effect on the absorbent action of the mucous membrane of the stomach and doubtless also of the small intestine.

A STUDY OF THE LIVER

What is the liver? The liver is one of the largest organs of the body. It is situated on the right side, immediately under the diaphragm. The liver of a full-grown person in good health weighs from three to four pounds. It is from ten to twelve inches long, and six or seven inches wide, and about three inches thick in its thickest part. The liver is divided into two principal parts, the right and left lobes. There are also three smaller lobes.



The liver

The liver is provided with a remarkable series of blood vessels (arteries and veins), for in addition to its function of separating the bile from the blood it brings about many changes in the nutrients which are brought to it in the blood. The liver bears practically the same relation to the introduction of nutriment into the body as do the lungs to the introduction of oxygen into the body.

The amount of sugar circulating in the blood is determined, as we have learned, by the liver. This amount is very small. Most of the sugars that are formed by the digestion of the carbohydrates in our food are not needed for immediate use. So, instead of being sent into circulation all at once, they are stored away after being changed by the liver into a sugar-producing substance known as *glycogen.* Glycogen may be regarded as a reserve supply of carbohydrates. Little by little it is reconverted into sugar and sent into the blood, where it is burned according to the needs of the body. Thus we see that it is not necessary to eat sugar or starch constantly in order to supply fuel to the body, for when we eat more than is needed the excess is at once stored away to be used at another time.

Glycogen is not stored solely in the liver. It is found elsewhere, especially in the muscular

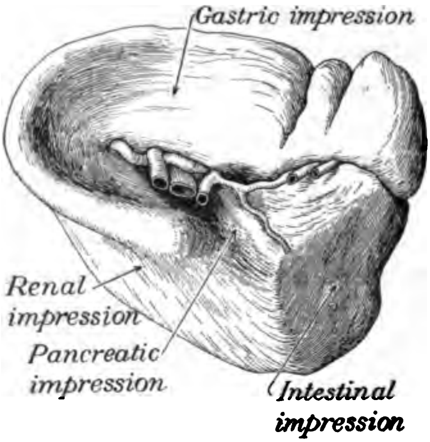
tissues of the body. In certain kinds of meat, such as that of the horse and the lobster, there is a large amount of glycogen, so much so indeed that such meats taste sweet. The liver also converts certain elements of protein digestion into sugar.

What other important function has the liver? The liver has a very important function as an excretory organ. The formation of the bile, which is largely a waste product, is an instance of this. Urea, which is excreted in the urine, is manufactured chiefly in the liver from the final products of the digestion of proteins. It then enters the blood, and the kidneys separate it from the blood and pass it on to the bladder, whence it is excreted.

THE SPLEEN

Something about the spleen. The spleen is situated on the left side, and very near the end of the stomach that is turned toward the heart. For many years the spleen was a mystery to those studying the growth and development of the body. It was thought to be an organ which had no function, because it had no duct by means of which its secretions could reach any part of the intestines. By some it was thought to be the seat of bad passions, such as anger and envy. A later study of the glands of the

body has shown that they may pour their excretions into the blood without the aid of a duct, sending them direct through the absorbing vessels of the organ itself. This may be true also of the spleen, although even yet the activities of this organ are not completely understood.



The spleen

The spleen is thought to have important functions especially in connection with the red corpuscles of the blood. A large percentage of iron is found in the spleen. Iron is the delivery wagon which carries oxygen in the blood to the tissues.

The presence of certain substances in the spleen which are important constituents of the animal body is another reason for believing that the spleen plays an important part in digestion. But it is certain that of all the organs of the body of any size the spleen must be regarded as the least important, since it has been found that if it is cut out of the body,

life is not necessarily endangered by its absence. Animals continue to live and remain apparently in good health after the spleen has been removed.

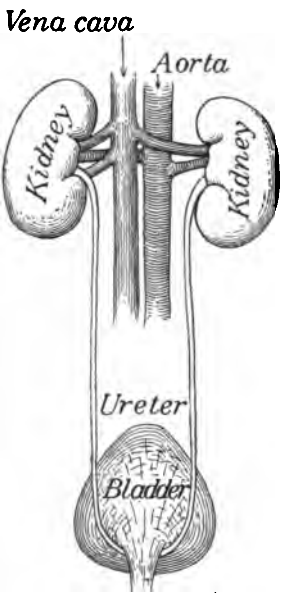
The spleen goes through certain changes in size which keep step with the ingestion and digestion of food. After eating, it has been noted that the spleen increases in size, continues to increase for several hours, and then slowly returns to its original size. Thus it is evident that the spleen in some way is in sympathy with, or is affected by, the process of digestion.

In a grown person weighing one hundred fifty pounds, the spleen weighs approximately one half pound. In very old persons the spleen is found to diminish in proportion to the weight of the body. In certain diseases it becomes very much enlarged, and has been known in extreme cases to weigh as much as twelve or fifteen pounds.

In general it may be said that we know less about the functions of the spleen than of any other important organ in the body.

XXVII. A Study of the Kidneys

What is the function of the kidneys? The kidneys are situated in the lower back part of the abdominal cavity, one on each side. They are connected with the bladder by excretory tubes. The function of the kidneys is to separate the urine from the blood and pour it into the bladder for excretion from the body. The constituents of the urine other than water are the excess of mineral salts that have been taken in with the food, after they have served their function in the body; the substances formed from the final products of protein digestion, in the form of urea; and the sulphuric acid compounds of indol, skatol, phenol, and uric acid.



The kidneys, bladder, and ducts

The principal constituent of the urine is urea. Urea, although a normal product of the disintegration of protein matter in the system, must be promptly eliminated

from the blood. It is to the kidneys that we owe our safety from acute and fatal poisoning with urea. If the kidneys cease to act, as is the case in some diseases, death follows within a short time. The importance of the kidneys from the point of view of health is therefore very great.

The kidney is about four inches in length, two inches in breadth, and one inch in thickness. The left kidney is somewhat longer and thinner than the right. The right kidney, however, is situated a little lower down in the abdominal cavity than the left, because of the large space required by the liver, which lies just above it.

The excretory duct of the kidney is called the *ureter*. It leads from the kidney to the bladder. The duct leading from the bladder is called the *urethra*. The quantity of urine excreted varies greatly in different individuals and also in the same individual, and is determined largely by the character of the diet. When large quantities of water, or other liquids composed chiefly of water, are taken, the volume of the urine is increased. Under contrary conditions the quantity is diminished. For a grown person of ordinary size the quantity of urine excreted daily is approximately a little over a quart.

What are some of the common diseases of the kidneys? There are two common diseases of the

kidneys. These are very troublesome and dangerous and are due perhaps to causes entirely external to the kidneys themselves. We have learned that in the normal nourishment of the body the sugars are burned, forming chiefly carbon dioxide and water. Sugars, therefore, are not found as normal excretions in the urine.

There are certain conditions that may favor the appearance of sugar in the urine for a short time. For instance, the eating of enormous quantities of sugar may cause a temporary excretion of sugar in the urine. There are also certain temporary disorders, during which sugar may be excreted. In good health and with a well-ordered diet the sugar is entirely burned.

There is a disease, called *diabetes*, which is characterized by the presence of large quantities of sugar in the urine. While it is usually spoken of as a kidney disease, it is more properly a diet disease, and can be controlled to a great extent by diminishing the amount of sugars and starches in the food.

We have learned that protein matter normally digested in the body is reduced to the form of amino acids, in which form it is built up into the tissues of the body and finally broken down into urea, a constant and necessary ingredient of the urine. A considerable part of the protein is also converted into sugar. There are certain

disordered conditions of nutrition in which soluble protein, known as albumin, is separated from the blood through the kidneys and appears in the urine. When this is due to an organic condition or to malnutrition it is a dangerous form of disease and should receive prompt medical attention. The presence of albumin in the urine is easily ascertained by heating a little of the urine in a test tube, which will cause the albumin to coagulate. This disease, known as *Bright's disease* from the name of the physician who first described it accurately, is spoken of as a kidney disease, when perhaps the kidney is without blame in the matter and the disorder is really nutritional or systemic. In general, the diseases of the kidney, especially if of an inflammatory nature, are called *nephritis*, from the Greek names of the kidney and inflammation.

The proper functioning of the kidney and the proper evacuation of the bladder are necessary to health, and the principles on which the activity of these organs depends should be taught to all in order that health may be preserved.

XXVIII. The Blood Stream

What is the blood? The blood is the liquid which flows through the arteries and veins of the body, carrying nourishing materials with which to build tissues and to make them grow. It also carries the oxygen by means of which the heat and energy of the body are produced, and the mineral salts which maintain the blood in an alkaline condition and thus keep the muscles of the heart active in propelling the blood through the arteries. The blood also carries to the proper organs waste products, such as water, carbonic acid, urea, and used-up mineral salts.

What are the chief constituents of the blood? Water is the most abundant constituent of the blood, its proportion being nearly eighty-one parts in a hundred. Besides water, blood contains nitrogenous materials called *plasma*. In blood that has been removed from the body, the plasma hardens, forming what is called a "clot." If the clotted blood is washed with water, a fibrous substance known as *fibrin* is separated from the other contents of the blood. It is found to be of a yellowish-white tint, and is the substance resulting from the clotting of the plasma. The liquid left after the fibrin is separated is called *serum*.

What are other constituents of the blood? The blood is full of disk-like bodies of minute size which can be seen only with the aid of a magnifying glass. These bodies are called *corpuscles*. They are of two kinds, the red disks and the white disks. The red disks are really the oxygen carriers of the blood, and the white disks are especially active in safeguarding the health of the body. They are the policemen already referred to.

How soon does the blood clot after it leaves the body? The blood of different individuals varies greatly in this respect. It also varies in the same person, according to the state of health. In some diseases the blood, when removed from the body, does not clot at all. In others, the blood clots while it is still in the body. In the latter case the clots lodge in the valves of the heart and death speedily follows.

The usual time required for healthy blood to clot after it flows from the body is from five to ten minutes.

How do the white corpuscles protect the health? The white corpuscles were for many years objects of much speculation. Their true function was not known positively until a short time ago. The white corpuscles seem to have a life of their own, and to be able to govern their own movements. They do not remain at

rest and are not satisfied to be carried along mechanically by the blood stream, but make little journeys on their own account. It is believed that these white cells have the power to destroy the germs of disease which enter the blood. In other words, they act as policemen, and when a disease germ enters the blood it is their duty to arrest it and either drive it out or destroy it.

What is the chief function of the blood? The blood of an animal, as the Bible has said, "is the life thereof." Blood and life are almost synonymous terms. To shed blood is to take life. The blood stream is, therefore, the life stream. The blood distributes to all parts of the body not only the materials that are necessary for growth and repair, but also those that provide heat and energy. The blood also carries the oxygen that is necessary to the vital functions. It also carries away the waste materials from the broken-down tissues.

The blood in a healthy state, flowing away from the heart through the arteries, carries a large volume of oxygen and carbon dioxide loosely combined with the coloring matter. It is then a brilliant red. When the blood returns to the heart through the veins it carries less oxygen but a very considerably increased quantity of carbon dioxide. This fact is demonstrated very beautifully by the change of color

which the blood undergoes when it passes from the arterial capillaries to the venous capillaries. The change of color is from a brilliant red to a dull purple inclining to blue.

It is certain that the blood in a healthy state never loses all its oxygen, nor all its carbon dioxide. There is a normal minimum content of carbon dioxide in the blood, and a normal maximum content of oxygen. The venous blood carries approximately half its volume, or about forty-five per cent, of carbon dioxide. This is reduced to thirty-eight per cent in the arterial blood.

If any very great change takes place in the blood to increase or diminish the minimum or maximum content of carbon dioxide or of oxygen, serious troubles or even fatal results may occur. Nature's system of breathing pure air is the best known means of maintaining the proper balance between the carbon dioxide and the oxygen in the blood.

What are blood purifiers? A great many patent medicines claiming that they will purify the blood are offered for sale. "Purifying the blood" is a phrase that has no definite scientific meaning. The blood is said to be impure whenever it carries too much or too little food or the seeds of disease. Impure substances in the blood are usually enzymes or poisons produced by the

work of bacteria. The blood may also carry organisms of a low order, like those germs which produce malaria or chills and fever. Other living organisms may be present in the blood, producing specific diseases. Thus any scientific method of purifying the blood must be based on an understanding of what the impurity is. That is, before we can purify the blood we must know what the dangerous substance in the blood is, and also know the exact process by means of which the disturbing substance can be removed.

It is evident that none but a scientific man who has made a specialty of the subject can discover whether there are impurities in the blood and what they are. This he does by means of certain chemical tests, with the microscope or in other ways. No one but the trained physician who understands the nature of the disorder can prescribe for it.

To undertake to purify the blood by the hit-or-miss plan — by sarsaparilla or other simples, such as are found in the blood-purifier advertisements of quacks — is to invite failure and threaten further danger.

The common so-called blood purifiers are usually mild cathartics by means of which the alimentary canal is thoroughly evacuated; or they may consist of certain herbs and roots

which have little or no effect in improving the condition of the blood. Beware of secret blood purifiers. As a rule they are fraudulent, and sometimes they are extremely injurious.

What happens when there is too much blood in the body? If both the volume of the blood and the soluble substances contained therein are increased beyond the normal because of an over-generous diet and the drinking of large quantities of liquids, a greater effort than usual is demanded of the heart. The pressure which the blood exerts on the heart and the arteries is increased. As the physician says, "the blood pressure is high." The blood pressure may be very easily measured by wrapping the arm with a rubber or other air-tight envelope to which a delicate gauge, carrying a mercurial column, is attached. Air is now pumped into the air-tight envelope until a sufficient pressure is produced on the arm to stop the pulsation at the wrist. When the pulsation at the wrist can no longer be felt the gauge of the instrument is read and the height of the mercury noted. This is the measure of the blood pressure.

In youth and in early life the blood pressure is usually very low. As we grow older, and the walls of the arteries get firmer, the blood pressure increases. If the arteries are diseased so that their walls are thickened and very much

hardened, the blood pressure is still greater. When the blood pressure reaches one hundred fifty millimeters of mercury we know either that old age is coming on, that there is too much blood, or that the artery walls are becoming too thick. A pressure of one hundred eighty to two hundred millimeters is evidence of a grave disease which must be carefully treated. In such cases, if the arterial degeneration has not proceeded too far, prompt relief may usually be gained by reducing the diet, and especially by omitting meats and confining the diet to simple cereals, fruits, nuts, and vegetables.

One of the principal dangers of a high blood pressure is the effect on the heart. The increased labor of the muscles of the heart and the pressure on its cavities cause the heart to enlarge, and such enlargement is usually dangerous.

What happens if there is too little blood in the body? If the volume of blood in the body becomes less than normal, or if the blood is thinned by the extraction of any of its normal ingredients, the health of the body is endangered. The condition of the blood can be determined by measuring the blood pressure, and by a chemical and microscopic examination. If it is too thin, a great diminution of the coloring matter of the blood is often noticeable, showing a deterioration of the blood through practically

all its contents. This condition causes paleness, colorless lips, a cessation of growth, general apathy and indifference, a lack of desire for exercise or work, and inability to prepare lessons or to do any mental work. The name physicians have given to the trouble is *anemia.*

Thin blood or too little blood is a very serious matter. In fact, it is a disease, and should receive careful medical attention. Usually some fault in the diet or disease of the organs of digestion is the cause of such deterioration of the character of the blood. A diet of fresh, clean milk, fresh eggs, fruits, vegetables, and fresh poultry or meat, properly cooked, will often remedy the trouble.

Why is it that so many children and grown people feel bad when winter turns to spring or spring to summer? An expression commonly heard in many parts of the country is "spring fever." In the first warm days of early spring many people, both young and old, complain of feeling tired and lose all desire for active exercise or hard work, mental or physical. Strictly speaking, it is not considered a disease, and so it is called "spring fever."

This feeling of weariness in spring is due wholly to the increased temperature or to faults in the diet. In cold weather we should eat a much larger amount of food, especially heat-giving

foods, than we do in warm weather. This is in order to supply additional warmth, since the heat of the body radiates, or is given off, so rapidly in the cold atmosphere. When spring comes on and it has grown warm, if we continue these habits of eating we consume more food than the body needs. To rid itself of the excess food the body uses up much of its vitality, so that one is likely to feel indolent and tired.

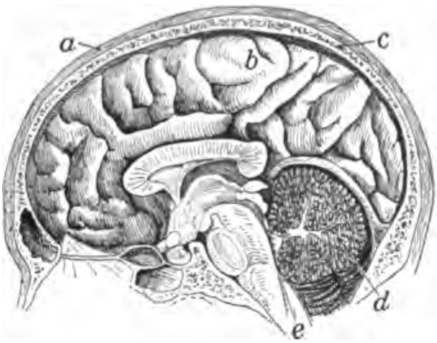
As the warm weather comes on, the amount of food eaten, by grown people as well as by children, should be promptly diminished. This will in a measure prevent the feeling of weariness.

In the "spring fever" disorder the blood is better nourished than it should be. It contains more nutrients than it can dispose of. It resembles a tradesman who, though there is less demand toward the end of the season for a certain article, still continues laying in a full supply of it. Very soon there is no demand for it. His shelves are piled high with goods suitable only for an earlier season, and he must devote all his energy to getting rid of them at any price. So it is with the blood current of people who in warm weather continue to eat too generously of the foods that were necessary in winter. The stimulation produced by the cold temperature of winter is lacking in the warm days of spring, thus adding to the trouble.

XXIX. A Study of the Nervous System

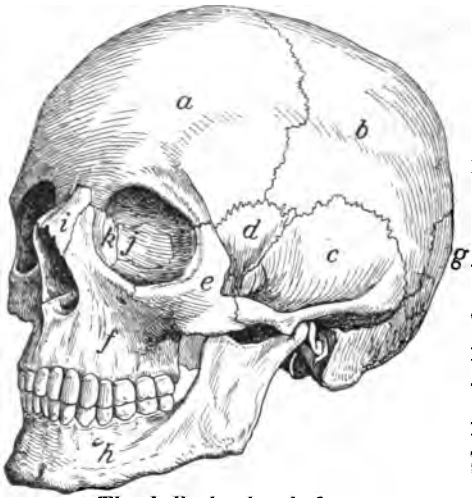
THE BRAIN

What are the functions of the brain? This is a very difficult question to answer, yet a perfectly natural one to ask. Within the skull is an organ, grayish-white on the outside, arranged in lobes and folds, richly supplied with blood vessels, and protected by a heavy, tough membrane. This organ we call the *brain*. That the brain is a most important organ is shown by the fact that nature has surrounded it with a fort or shield of bones to protect it from injury, blows, sudden changes in temperature, and other harmful influences. The shield of bones surrounding the brain is more or less spherical, and is completely closed except for a number of perforations in the under and facial surface. These openings



A section of the skull showing the brain
a, scalp; *b*, brain; *c*, skull; *d*, cerebellum; *e*, spinal cord

admit the spinal cord, the various nerves, and the arteries and veins which carry the blood to and from the brain.

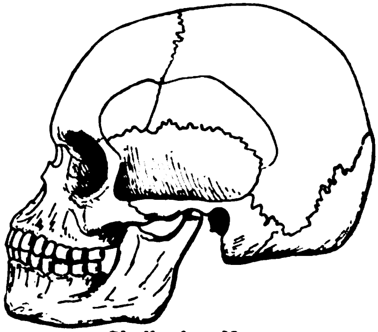


The skull, showing the bones
a, frontal; *b*, parietal; *c*, temporal; *d*, sphenoid; *e*, malar; *f*, superior maxillary (upper jaw); *g*, occipital; *h*, inferior maxillary (lower jaw); *i*, nasal: *j*, ethmoid; *k*, lachrymal

Although the term "skull" really includes all the bones of the head, it will be used in this discussion to refer only to that portion inclosing the brain. At the points that are most exposed to danger—as, for instance, the forehead and at the sides around the ears — the brain is provided with additional protection. Between the bony layers of the skull over the eyes is an open space, so that if you break in the outer layer of bone the inner layer may still remain uninjured. The bones back of and around the ears are also thickened.

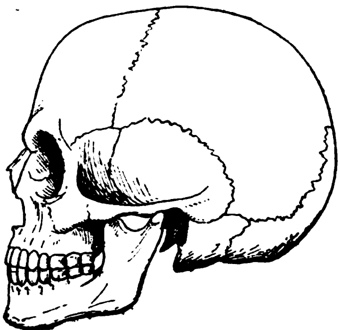
The outside of the skull is covered with the skin and the hair, which also aid in protecting the brain.

Altogether, there are twenty-two bones in the structure of the head. Eight of these form the skull, or the shield inclosing the brain. In infancy the bones of the skull are not joined. Between them are spaces composed of flexible substances that gradually harden into bones as the child grows older. In the adult the skull bones are usually so firmly united as to form practically one continual bone.



Skull of a Negro

The skull varies in size. The skulls of educated and civilized people are thought to have a larger capacity than those of ignorant or savage peoples. But the prevailing idea that the size of the brain is the sole index of intelligence is by no means true. Idiots and others of arrested mental development usually have small brains while many men of great mental powers have had large brains.



Skull of a Caucasian

The brain is supposed to be the organ of mental activity. Our intellect, in other words, is so closely associated with the functions of the brain as to warrant the statement that intelligence is directly due to the working of the brain. You may lose your foot or your hand or your leg or your arm without in any way affecting your mental and intellectual vigor. But the moment the brain is attacked, intelligence diminishes, mental power decreases, and mental activity may cease altogether.

Skull of a chimpanzee

The brain is divided into four general divisions: the large brain, occupying the greater part of the skull cavity and lying toward the front and the top; the small brain, lying at the base and toward the back of the skull; the expansion of the spinal cord within the skull; and a bridge-like structure at the base of the brain forming connecting links between its parts.

What is the total weight of the brain? In a grown man of average size the brain weighs about fifty ounces. In a woman it weighs about forty-five ounces. The weight of the brain varies in different individuals, but usually the variation from these figures is not more than about four

ounces. Occasionally a man has been found with a brain weighing sixty-five ounces or more, and once in a while a woman with a brain weighing from forty-eight to fifty ounces. The brains of very learned men are usually somewhat above the average size.

THE SPINAL CORD

What is the spinal cord? Next in importance to the brain is the *spinal cord*, a large mass of tissue located in the backbone. The backbone, known also as the *spinal column* or simply as the *spine*, consists of a series of bones placed one above the other. Through the center of each bone is an opening, so placed as to form a continuous canal throughout the length of the column. This canal contains the spinal cord.

Each of the thirty-three separate bones in the spinal column is called a *vertebra*. The continuous canal formed by the cavities in the *vertebrae* is not entirely circular, but more nearly of a triangular shape, especially toward the upper end of the spine.

The top bone of the spine is called the *atlas*, after the mythological giant, Atlas, who was said to bear the world on his shoulders. The skull rests on this first bone as the round globe was said to rest on the shoulders of Atlas.

The second bone from the top provides a movable joint on which the head may be turned from side to side, and for this reason it is known as the *axis*.

Spinal column from the left side

a, cervical; *b*, thoracic; *c*, lumbar; *d*, sacral; *e*, coccygeal

The other vertebrae next in order are numbered third, fourth, fifth, sixth, and so on.

The upper part of the spinal column is called *cervical* (neck), the middle part *dorsal* (back), and the lower part *lumbar* (loins).

The vertebrae are joined together by elastic bands of tissue, called *ligaments*, in such a way that the spinal column may be bent from side to side, or forward and backward, without permitting the bones to move out of place. If one bone were displaced or injured so as to change the form of the central canal or to interrupt its continuity in any way, the spinal cord, the delicate nerve substance in the interior of the canal, would be injured or compressed. If this should happen all parts of the body supplied by nerves having their origin in the spinal cord below the point of injury would be paralyzed.

There are two kinds of *paralysis* from which we may suffer. Paralysis may be caused by an

injury to the brain, or by an injury to the spinal cord. In an injury to one side of the brain all of the opposite side of the body is paralyzed. But in an injury to the spinal cord both sides of the body below the point of injury are paralyzed. Thus in a case of paralysis any one who knows these facts can determine whether the trouble is due to an injury to the brain or to the spinal cord.


An improper sitting position

The backbone or spine in a normal, healthy individual is curved when viewed from the side. But it is straight when viewed from the back or from the front.

What is meant by curvature of the spine? Sometimes there is a sharp, abnormal bend in the spine. Such deformity is known as *curvature of the spine*. People who spend much time indoors, and especially if seated when at work, often have a slight curvature to the left, caused by the fact that the right side is used more frequently than the left.

Most of the diseases of the spinal cord begin with an injury, received very often in play or

Improper position of the body when standing

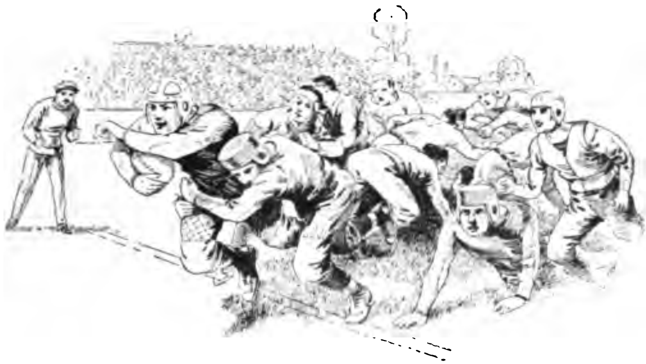
in the course of violent exercise. Some children injured in this way may recover entirely, while such an injury to other children may cause the development of tuberculosis in the part of the spine that was injured. The result is permanent deformity and very often early death. Any injury to the spine should at once receive the careful attention of a competent physician. It is too serious a matter to overlook. Often serious deformities that cause lifelong suffering may be prevented by prompt attention to such an injury.

Children should be cautioned against jumping from a great height down on to a hard surface. The shock which results often causes an injury to the spine. Injury to the spine is liable to occur in violent play, as in wrestling or in football playing. Football playing cannot be commended as an exercise for young children and is dangerous even for those of more mature age. For young

Improper position of the body when walking

people such sports as baseball, tennis, running games, and swimming are greatly to be preferred to football.

What is the nature and function of the spinal cord? The spinal cord is an essential part of the nerve system. It consists of two parts. The chief



A game of football

function of one part is to control physical movements; that of the other, to receive and transmit sensation. The substance composing the spinal cord is similar to that of the brain. It is also somewhat similar to the substance of the nerves, except that it is softer and more plastic. The functions of the spinal cord are more complicated than those of the nerves.

The spinal cord is inclosed in a strong protecting membrane like that wrapped around the brain, and is placed within the bones of the

spine for the same reason that the brain is placed within the bones of the skull, that is, for its protection.

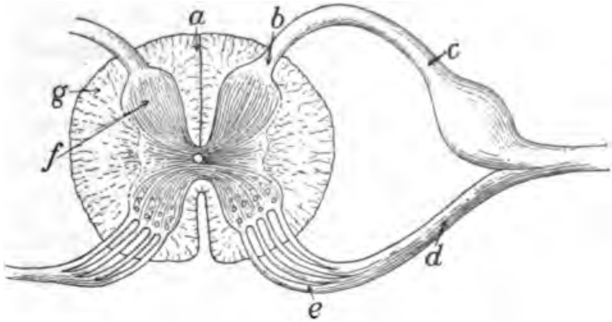
The spinal cord may be thought of as a continuation of the brain, for it is so closely associated with the brain in its functions that it is almost impossible to distinguish between the two. While the brain is believed to be the special seat of our intellectual sensations and perceptions, the spinal cord is thought to be that part of the same system which has charge of our physical movements and sensations. When we learn history, arithmetic, grammar, language, and science, we are said to be cultivating our brains; when we acquire skill at play, or manual skill in such occupations as wood or iron working, in playing upon a musical instrument, or in using a brush, we are supposed to be educating the spinal cord. That scheme of education is best which includes the education of both the brain and the spine, so that we may become skilled in play, in work, and in exercise, and at the same time acquire knowledge.

THE NERVES

What are the nerves? The nerves are fibers connecting the brain and the spinal cord with every part of the body. They have the property of transmitting sensations of pleasure or

of pain. They control the voluntary muscular movements, and also, to a great extent if not entirely, the involuntary muscular movements.

As the nerves approach the surface of the body they become finer and branch out into numerous filaments. These are so numerous



Section through spinal cord showing nerves

a, spinal cord; *b*, emerging posterior root; *c*, sensory nerve; *d*, motor nerve; *e*, emerging anterior nerve; *f*, gray matter; *g*, white matter

that it is difficult to prick the skin with a fine needle without touching a nerve and feeling a sensation of pain. This sensation of pain is supposed to be carried along the nerve filaments to the spinal cord in a way that is not well understood. The pain is not really carried, but the impulse which causes its perception. It then passes on through the spinal cord to the brain, where the sensation is registered as though it were a telegraphic message received at the end of a wire. Then another wave is sent back through the spinal cord and the nerve

which produces a movement of the muscles.

When your finger touches an object hot enough to burn, you quickly though not instantly receive a sensation of pain. This is immediately followed by a sudden muscular movement which withdraws your finger from the hot surface. But this does not happen in time to avoid a burn. If the transmission of the sensation through the nerve and the reply to the message had been instantaneous your finger would have been withdrawn before it was burned. This simple experience aptly illustrates the phenomenon of the nerve functions.

Can the speed of transmission through the nerves be measured? The speed of the transmission of nerve force along the nerves can be measured, though not with absolute exactness. It is known that the movement which takes place in the nerves is not in any way to be compared with electricity for speed; it is very much slower. So, except by way of illustration, it is not correct to compare the nerve force with an electric current, or the nerve with a telegraph wire.

It has been estimated that the velocity of the nerve sensation in the adult human being is about 30.5 to 33 yards per second. There is some difference in the results obtained by scientists experimenting in different ways. The rate of transmission of sensation in infants is

much slower. In some animals the rate of transmission is even slower than in infants. In the lobster it has been discovered to be about six and a half yards per second, or one fifth as rapid as in the normal human being; in fish the rate is less than one fifth of a yard per second. But these figures are only approximate. All we can say definitely is that the movement in the nerve fiber, or the rate at which a sensation is carried along the nerve, is many thousands of times less rapid than the rate of transmission of a wave of electricity through a copper wire.

What is the function of the nerves? The nerves, as we have learned, have two distinct functions. One is to carry sensations of all kinds—heat, cold, pain, pleasure—to the nerve centers; the other, to carry an impulse from the nerve centers to produce muscular contraction or movement. The nerves are the means of communication between our nerve centers, the spinal cord and the brain, and the external world.

What are voluntary and involuntary movements? If you decide to reach your hand out for a book, the impulse to take the book originated in the brain center by a strange and mysterious force that we call the *will*. This impulse was carried along the nerves to produce a certain motion. You reach out your hand and take

the book as predetermined by your will. Such a movement is called a *voluntary* movement.

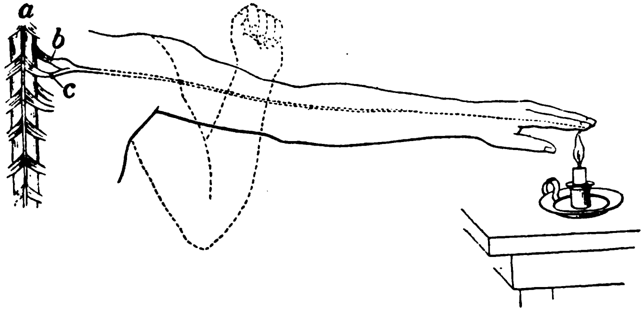
On the other hand, if your finger happens to touch a hot stove there is an entirely different process. A message is sent from your finger to the receiving office in your brain that your finger is burning. Immediately the operator sends back a message to the muscle controlling your arm and hand to withdraw your finger from the stove. Such a movement is called *involuntary*. No person whose hand by chance comes in contact with a surface hot enough to burn it, can control this movement. It is true that by the exercise of your will you can deliberately place your hand on a burning surface and hold it there; that is, if your will is strong enough. But such an action is voluntary, while the action I have described is involuntary.

The beating of your heart is evidently a motion caused by nerve control. But the impulses which cause this motion are produced without your control, and the motion that results cannot be stopped by mere force of will. The movement of the diaphragm in breathing, by means of which the air is taken into and sent out of the lungs, is also involuntary. It is true that by exercising your will you can hold your breath for a certain length of time. There may be instances of persons who have

held their breath long enough to cause death, but this is not possible for the ordinary person. No matter how much we may wish to die, we cannot commit suicide by holding our breath.

There is a distinct difference between the function of the nerves in carrying a sensation and in that of carrying an impulse for muscular movement. In other words, one kind of mechanism is required for conveying a sensation and another for carrying an impulse to move a muscle. Separate wires—that is, separate nerve filaments—are provided which are connected with the spinal cord in different ways and at different places. Thus the telegraphic nerve system of the body is of the duplex, or double, variety. The nerve filaments carrying sensations to the brain are called *sensory* nerves; those transmitting an impulse from the brain to the muscles are called *motor* nerves. The sensory-nerve filaments and the motor-nerve filaments are usually present side by side in all parts of the body wherever sensations are produced and movements required. But widely separate filaments may take part in sensory and motor processes. For instance, the sensation of burning the tip of the finger is transmitted by the very few sensory nerves affected by the burn. But the impulse to act is sent through all the motor nerves leading to the

muscles of the arm and the hand and the finger. Thus, while the sensation of pain is transmitted



Reflex action. Message of a sensory nerve
a, spinal cord; *b*, sensory nerve; *c*, motor nerve

by a very few nerves, the effort to escape the danger or pain comes back by hundreds of nerves, some of them widely separated.

The action of widely separated sensory and motor nerves may be illustrated in another way. The nerves of the eye are spread over the membrane at the back of the eye. This membrane is called the *retina*. When you see a person or object the sensation of sight is transmitted along the sensory nerves of the eye. In answer to that sensation, either you may start in the direction of the person or object or you may turn and run away from it. In either case the motor nerves bring nearly all the muscles of the body into action as a result of the sensation sent to the brain along the nerve of sight.

The nerves branch out from the brain to all parts of the body in much the same way as the arteries branch out from the heart, and come back from all parts of the body in much the same way as do the veins.

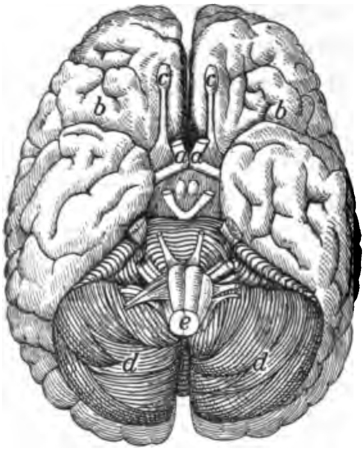
The nerve system is very intricate. But the general idea of its structure and functions that has been given is sufficient for our purposes. There are some things about it that it would be impossible to explain. The whole action of the nervous system is one of the great problems that science has not yet been able to solve. If we could understand fully everything that happens in the nervous system from the time we see a rose until we pluck it and pin it on for an adornment, life would have no more mysteries for us. We know where the nerves are, we know what their functions are, but by what means and by what power they perform them remains as yet unrevealed.

What are some of the principal nerves of the body? The nerves of sensation and of motion are distributed over all parts of the body. Among them are certain special nerves that preside over special functions. These nerves we ought to know something about.

XXX. A Study of the Senses

THE SENSE OF SIGHT

What is the optic nerve? The optic nerve, or the nerve that makes it possible for us to see, is one of the most important of the special nerves. The eye, the organ of vision, is one of the wonders of the human body. It is shaped much like a big marble, and is filled with materials that permit light to pass through as light passes through a window pane. You have seen how a magnifying glass seems to enlarge an object seen through it. Such a glass is called a *lens*. The eye is provided with a lens made of a transparent substance held in a transparent membrane. This lens serves to concentrate the rays of light on a black membrane, called the *retina*, at the back of the eye.



Under surface of brain showing the optic nerve

a,a, optic nerve; *b,b,* cerebrum; *c,c,* olfactory nerve bulbs; *d,d,* cerebellum; *e,* spinal cord

In the retina are distributed the nerves of vision. The sensations produced on these nerves in the

retina by the rays of light that pass through the lens of the eye are carried along the nerve called the *optic* nerve to its origin in the brain. In the brain and the spinal cord are registered the images produced on the retina.

If you look closely at the eye of your friend you will see in it the image of yourself. But that image is merely the reflection of yourself as from a mirror. The image your friend receives of you lies on the black curtain or retina at the back of the eye. But if you could

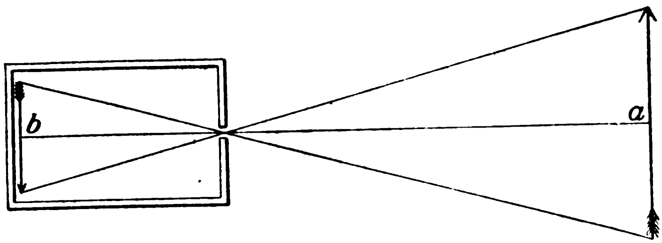


Diagram of a camera showing inverted image

see the retina you would see nothing but a black surface. There is no difference in principle between the way the eye is made and the way a camera is made. Both have a lens in front through which the light is concentrated on a black sensitive curtain at the back.

The image of an object, registered in the brain, is the same for all normal eyes. Looking at a picture you will see just what your neighbor sees,

unless your eye or your neighbor's is defective.

What are the chief parts of the eye? The eye is an almost perfectly round ball from three fourths of an inch to an inch in diameter, so placed in a depression in the bones of the face and skull as to expose only a portion of its surface to view. Its form is determined largely by its chief exterior coating.

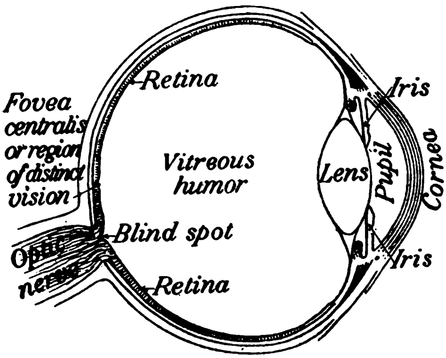


Diagram of the eye

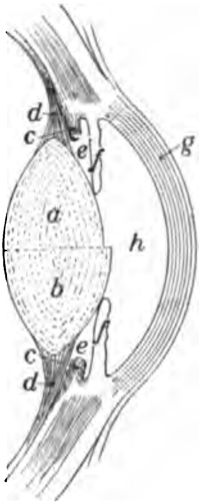
The white outer coat, a portion of which is exposed between the lids, is known as the hard coat. This coat is *opaque*, that is, light cannot pass through it, except in the portion covering the round colored spot in the front. That portion of the outer coat is called the *cornea*. The cornea projects from the surface of the eyeball so that it looks as if it were a part of a smaller sphere lying within a larger one.

The eye is filled with a transparent liquid substance. Toward the front, just behind the cornea, is a transparent semi-solid substance known as the *crystalline* lens. It is made up of various layers or cells, which may be compared

to the layers of an onion so far as structure is concerned. It is through this lens that the rays of light pass to the sensitive inside coating of the eye, which has already been spoken of as the retina. The crystalline lens is so called because formerly lenses of commerce were cut from quartz crystal and resembled in shape and in function the lens in the eye.

The retina is a black membrane, over which the numberless filaments of the nerve of vision, the optic nerve, are distributed.

Back of the cornea and in front of the lens is a colored curtain called the *iris*. In the center of the iris is an opening the size of which is adjustable according to the intensity of the light. This opening is called the *pupil*. When the light is strong the iris contracts so that the opening is very small; in the dark the iris expands so that the opening is very large. The iris corresponds to the diaphragm of a camera. If the light is very intense the diaphragm of the camera is set so that the hole through which the light enters is very small. If the light is



Section of the eye showing lens

a, lens adjusted for near objects; **b**, lens adjusted for far objects; **c, c**, ciliary process; **d, d**, suspensory ligament; **e, e**, posterior chamber; **f, f**, iris; **g**, cornea; **h**, anterior chamber

less intense the hole in the diaphragm of the camera is made larger. This adjustment of the opening in the iris is accomplished by means of small muscles which act automatically.

What causes the color of the eye? The color of the eye is due to the coloring pigment in this movable diaphragm. In all eyes the pupil appears to be nothing but a black spot. What you see there is probably a portion of the retina. What we call the "color" of the eye is determined by the color of the iris. The color of the iris is never black, but varies from deep brown through all the different shades to light gray or blue.

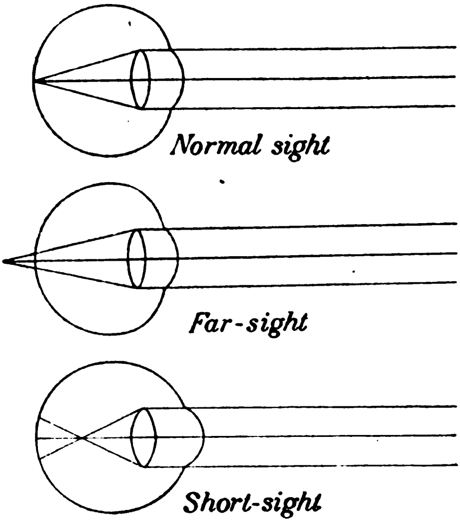
Are there other lenses in the eye besides the crystalline lens? The fluid in the front part of the eye, between the crystalline lens and the cornea, forms another lens. This fluid is called *aqueous*, meaning watery, because in its density it does not differ largely from water. The fluid filling the greater part of the cavity of the eye behind the crystalline lens also forms a lens. This fluid is called *vitreous*. Vitreous means "resembling glass." The vitreous substance in the eye, however, resembles glass only in its faculty of transparency. It is a thin, jelly-like substance, so inclosed as to form a lens.

What is blindness? Blindness is sometimes the result of some defect in the optic nerve that has

made it incapable of transmitting impressions. It may also be caused by some defect in the eye itself. If there is a defect in the lens, light cannot be transmitted or concentrated properly on the retina. If there is a defect in the retina, the nerves cannot receive the impression or transmit it to the optic nerve. The brain cells that receive the impression may be diseased. Blindness may result from defects in the make-up of the organ itself, from defects in the transmitting apparatus of the optic nerve, or from defective brain cells. When we say that an eye is "put out," as the saying is, it does not necessarily mean that the eye is removed from its socket but that it is so injured that the light no longer enters it. The destruction of the lenses of the eye by accident, or through the hardening of these lenses because of old age or some other reason, may result in blindness.

What is the disease known as cataract? The word "cataract" usually makes us think of water falling over a steep cliff. But when we use this word in speaking of the eye we mean the hardening and whitening of one of the lenses. When the crystalline lens becomes hardened and whitened so the light can no longer penetrate to the retina, it may be removed and the remaining lens used in its place. The vision will be restored, but it will not be so perfect as before.

What is nearsightedness? The lenses of the eye may be so formed as to require a nearer view of an object in order that its image may be correctly concentrated on the retina. In other words, such lenses are too powerful and concentrate the light too quickly. In such cases the object at which a nearsighted person is looking, as for instance the print of a book, must be brought nearer to the eye than is normally required.



Diagrams of eye showing normal, far, and short sight

What is farsightedness? Farsightedness results when the lens is so formed that it does not concentrate the light quickly enough. For that reason a farsighted person can see better if the object is at a greater distance. In perfectly normal eyes the lenses are so adjusted that the person can read print very well at a normal distance of fifteen or twenty inches and also

can see objects at a distance of one hundred feet, or half a mile, or mountains ten miles or even farther.

How are these faults corrected? With a knowledge of the causes of nearsightedness and farsightedness—that is, of the laws that regulate the concentration of light—the man who has the technical skill can so grind lenses of glass as to supplement or correct the deficiency of the natural lenses of the eye. For nearsightedness a lens of one form and thickness is ground, and for farsightedness, a lens of another form and thickness. In this way opticians are able to correct faults in vision due to the structure of the eye and greatly benefit those who suffer therefrom.

What is astigmatism? Astigmatism is the term applied to that condition of the eyes in which the light is not conveyed to a point on the retina but forms a line instead. This is due to faulty curvature of the cornea.

How may astigmatism be corrected? For such cases the skilled optician provides glasses in which the form of the lens corrects the defect in the cornea and causes the light to converge to a point.

What is meant by the term "cross-eyed"? The movement of the eyes in their sockets is controlled by a great many muscles acting together.

The eye can be moved to the right or left, up or down, or in a circle, in order that we may look at objects in different places without turning our heads. In normal eyes the movements of the muscles are coördinated; that is, they work so as to move both eyes at the same time in exactly the same way. You cannot move one eye without moving the other, though you can move one finger without moving another. And you cannot move one eye in one direction and the other in another direction.

Eyes may be crossed in two ways. They may either look toward each other, so that the lines of vision cross, or they may be turned outward, though such cases are rare.

How may cross-eye be corrected? Cross-eye cannot be corrected by any kind of mechanical contrivance. If there is only a slight affection it may be helped by a skillful adjustment of eye glasses. There are only two plans to follow—in marked chronic cases either to leave the task to nature, which sometimes corrects this trouble; or to secure the services of a surgeon. An eye is turned too far in one direction or the other because one set of muscles is stronger than the other. For instance, the muscle that pulls the eye toward the nose must not be stronger or weaker than the muscle that pulls the eye in the opposite direction. Thus both eyes can look

straight forward or they can turn an equal distance to the left or to the right. If the muscle that pulls the eye toward the nose should become stronger than the muscle that pulls outward, the eye would be turned in. In such cases the skillful surgeon can cut some of the filaments of the muscle that is too strong.

Crossing of eyes is often due to eye strain which arises from the intense effort to compensate defects in the dioptic apparatus. Glasses correcting lens defects often correct crossing. The eyes will cross without the glasses but not with them.

Has the eye any relation to health? The eye is very important in its relation to health. Many forms of headache are due to defects in the eye. When these defects are remedied by the use of glasses ground correctly, the headache disappears and the general health is improved.

What is meant by "sore eyes"? In addition to the disorders to which attention has already been called, the eye may be affected by various kinds of inflammation which attack the membranes surrounding it. These inflammations are often of an infectious character. The eye inflamed by overuse may cause the blood vessels of the eye to carry to it a larger amount of blood than is needed. The stranding of these unnecessary particles of blood in the capillaries

produces what we call "bloodshot" eyes. Overstraining, or using the eye in too brilliant a light, also causes similar troubles.

When reading, one should never face the light. It should come obliquely from behind, over one or the other shoulder of the reader as is most convenient. The green light that is often used is produced from tubes filled with mercury vapor or by the use of green shades. This light is less harmful to the eyes than the white or brilliant light of the electric arc or incandescent lamp, or of the gas jet surrounded with a mantel.

Abraham Lincoln used the light from a burning log in the fireplace. The light given off by such a flame is yellowish and is not very brilliant, so probably it did not hurt his eyes. We do not read by that kind of light now, and we are not so careful as we should be to shade our lights or sit in a position to avoid eye strain.

Has light any relation to health? Light is of the highest importance to good health. Without light, normal growth is impossible. If you put a potato in moist earth in a dark cellar it will sprout, but the plant will never reach mature growth and will have no color. If you keep a child in a dark room he may grow, but he will be thin, white, and imperfectly developed.

But as a rule the beginning of all growth

requires an absence of light. A seed will germinate much more readily when covered with earth or if it is kept in the dark than if exposed to the light of the sun. All bacteria are vegetables of a primitive character, and hence, like the seed of a vegetable, which is its primitive stage, the germs grow best in the dark. So light is of the highest importance to us, not only because it helps us to grow, but also because of its ability to kill germs that threaten our health. There is no better *germicide*, or germ killer, than bright sunlight.

Light is as necessary to our existence as heat. Fortunately, one usually accompanies the other. The sun is the origin, so far as our world is concerned, of both light and heat. Light is indispensable to our health, and to it we owe most of the joys of life.

What is the value of light in convalescence? The convalescent—the person who is on the way from sickness to health—should be kept as much as possible in the sunlight. Unfortunately there are some diseases in which light is injurious, as, for instance, in diseases of the eye or diseases which affect the eye. Measles makes the eye sensitive, and the boy or girl suffering from this disease must be kept in the dark. The person suffering from inflammation of the membranes of the eye must also be kept in the

dark. But if a person has tuberculosis, or is recovering from some ordinary illness, he should remain constantly in a well-lighted as well as a well-ventilated place.

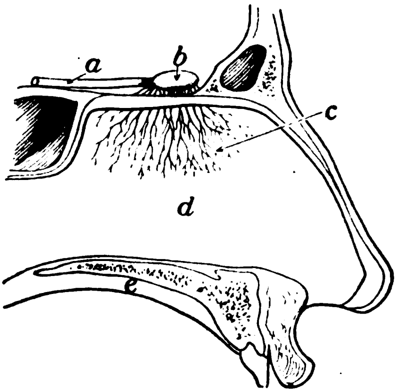
Light is very effective in preventing the loss of hair. If we go bareheaded as much as we can, and let the sun shine on our heads, there will be fewer bald heads in the future than there are at the present day. Tight hats cut off the blood supply from the scalp and thus promote baldness. The sun's rays tend to kill germs that destroy the hair.

THE SENSE OF SMELL

What is the olfactory nerve? The sense of smell is communicated to the brain through two nerves, the filaments of which are distributed in the shape of a fan principally on both sides of the membrane separating the nostrils. These nerves are called the *olfactory* nerves. They connect directly with two bulbs in the base of the brain, called the olfactory bulbs, and these in turn are connected with that particular part of the brain that apparently presides over the sense of smell.

How do the nerves carry the sensation of smell? Just how the olfactory nerves receive and transmit the sensation of smell is not understood any better than how nerves carry any kind of

sensation. All we know is that it is their function to do so. Substances that have an odor and therefore affect the sense of smell are believed to give off very minute particles that carry the odor. These particles of matter strike against the filaments of the nerves in the nasal passages and excite them in such a way as to produce a certain sensation. This sensation is transmitted through the olfactory nerves to the olfactory bulbs and then to the brain. The sensation may be one of two general kinds, the agreeable or the disagreeable. The odors that produce an agreeable sensation do not excite the nerve filaments in the same way as do those that produce a disagreeable sensation. What the difference is, we do not know.

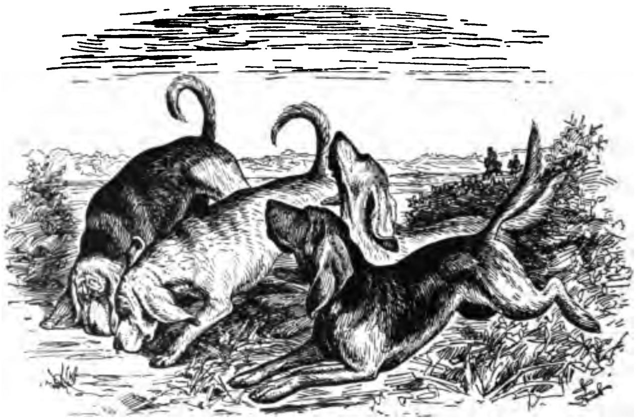


Section of nose showing olfactory nerve

a, olfactory tract; *b*, olfactory bulb; *c*, olfactory nerves; *d*, nasal cavity; *e*, roof of mouth

Does the sense of smell in various animals differ in keenness? Very much so. Some animals have a sense of smell that is almost incredible in its keenness. By means of this wonderfully developed faculty some dogs are able to trace

the course which an animal or a man has taken. The dog and the man are at almost opposite



Bloodhounds scenting the trail

extremes in regard to the sense of smell. In man this sense is at a decidedly low stage of development, while in the dog it is very highly developed. The hound can follow a trail swiftly and unerringly, so easily do his olfactory nerves respond to the slightest stimulus. Bloodhounds can distinguish the odor of one individual from that of another, and can thus track an individual on trails over which many other people have passed. The keenness of the sense of smell in such cases seems almost beyond comprehension.

Why do colds diminish the keenness of scent? It is easy to understand how a cold affecting

the nasal passages can diminish the sense of smell and even stop it entirely. The olfactory nerve filaments are placed in the mucous membrane of the nose in such a way that in a state of health they are easily affected by odors. A cold in the nose causes inflammation, a temporary thickening of the mucous membrane, and the excretion of large quantities of mucus which cover the membrane and thus prevent odors from affecting the nerve filaments. All these conditions diminish the activity of the nerve filaments. When the inflammation has reached a certain degree the sense of smell is for a time entirely lost.

Are there differences in the keenness of scent among different persons? There is just as much difference in the development of the sense of smell in individuals as there is in the development of other faculties. In some people the sense of smell is very keen. There are many persons who cultivate it, for it is as capable of cultivation as any other faculty. In those who use the sense of smell professionally to distinguish between various objects, this sense becomes very highly developed. The expert distinguishes the various grades of teas, coffees, alcoholic beverages, and other products largely by the sense of smell. Some persons also are naturally endowed with a keener sense of smell

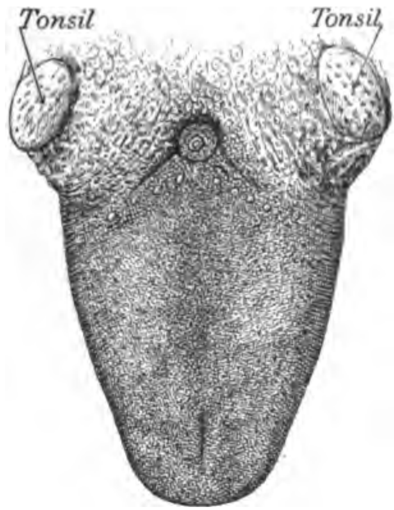
than others, and so are much more capable of discriminating between different odors.

Does the sense of smell have any relation to health? The sense of smell has important relations to health. Most foods have an agreeable odor when they are fresh and suitable for eating. If they are decayed or unwholesome the agreeable odor is changed to a disagreeable one. Thus the sense of smell tells us what is good for us to eat and what is bad. Though the odor of a fresh egg is not particularly agreeable, still it is not offensive. But if the egg is bad our sense of smell tells us immediately that it is unfit for food. In the same way harmful gases mingled with the atmosphere are revealed by their odor and we are thus placed on our guard. Thus we see that the sense of smell aids us in maintaining health in many important ways.

What is the relation of the sense of smell to the flavor of our foods and drinks? The term "flavor" is often used incorrectly. Flavor is not taste alone, nor is it odor alone. The flavor of a food is its taste and smell combined. Sugar, for instance, tastes very sweet, but as it does not produce a sense of smell, sugar has no flavor. In order to have a flavor a substance must have the properties which excite, at the same time, both the nerve of taste and the nerve of smell.

THE SENSE OF TASTE

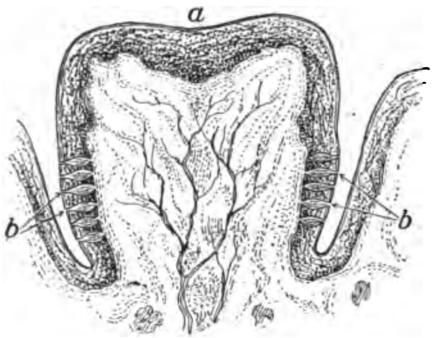
What is the nerve of taste? Just as we associate the nose with the idea of odor, so do we associate the tongue with the idea of taste. The tongue has various functions. It is especially useful in speaking. Without the tongue, the sounds made by means of the vocal cords would not be *articulate;* that is, they could not be formed into the definite sounds represented in writing by means of letters and syllables. Another important function of the tongue is to assist in chewing and in carrying the food into the back part of the mouth, where it is seized by the muscles of the throat and carried into the esophagus. All these functions of the tongue are important and useful. In our present discussion we shall regard the tongue particularly as the organ of taste.



The tongue

The tongue is covered with numerous small projections called *papillae,* which form a part

of the mucous membrane covering the tongue. The papillae, when magnified, appear to be projections of considerable size. The nerve of taste, called the *gustatory* nerve, divides into minute threads or filaments that pass into the papillae and are distributed over parts of the mucous membrane of the tongue. It does not appear to communicate directly with the brain, but reaches it in connection with other nerves, and especially with the one known as the fifth nerve. That certain portions of the brain have to do almost entirely with the sense of taste is evident from the fact that injuries to certain connections of the fifth nerve in the brain destroy or modify very materially the sense of taste.



Section of papillae valata of the human tongue, showing taste buds
a, papilla; *b*, *b*, taste buds

How many kinds of taste do we possess? The sensations produced in the nerve of smell have been classified broadly as agreeable and disagreeable. A more detailed classification can be made of the various sensations of taste. The sense of sweetness is usually a highly

developed sensation. There is also a distinct sensation of bitterness. But the sensation we call sour, or acid, is entirely distinct from these two. Probably a sour or acid taste is more nearly the opposite of a sweet taste than the taste we call bitter. Forming another distinct class of taste sensations are those caused by common salt and similar substances. This is called the saline or salt taste. As we have already learned, the sense of taste also has the function, in coöperation with the sense of smell, of perceiving flavor.

These separate sensations may be regarded as the fundamental taste sensations. But when mingled they produce numberless variations and combinations in which all the fundamental kinds take part.

What is the theory of transmission of the sense of taste? We find that the transmission to the brain of all our knowledge of the world around us depends on actual physical contact of substances with the various nerves. This is also true of the transmission of taste. The substances which produce the sensation of taste must come into direct contact with the nerve filaments distributed at or near the surface of the mucous membrane of the tongue and in the papillae. We cannot conceive of any other way in which the sensation of taste can be produced.

It is probable that the nerves of taste in various parts of the tongue have different degrees of sensibility, and even perceive different kinds of taste according to their location. The expert taster can distinguish the difference between the taste of a substance when held near the tip of the tongue and the taste of the same substance when held farther back toward the throat. It is reasonable to suppose that the anterior or front filaments are less delicate than the posterior or back filaments, since they come into contact with the food when it is in a more or less solid state. It may be that the differences in the taste sense in different parts of the tongue are not due to any essential differences in the nerve, but to the degree of sensitiveness to impressions. It is generally believed that a bitter taste is most readily perceived near the back of the tongue. It is even claimed that at the tip of the tongue a bitter taste cannot be perceived at all.

In what condition must a material be in order to produce the sensation of taste? There is an old Latin axiom which reads, "Bodies do not act unless they are in solution." This rule may be applied, also, to the phenomenon of taste. If the surface of the tongue is perfectly dry and the substance placed on it is perfectly dry, no sensation of taste is produced. So it is essential

that the substance must be either in solution or else so finely cut up that it has the properties of a liquid.

The taste of a hard substance develops quite rapidly with chewing, and a much stronger sensation of taste is produced than when the food is undissolved or in coarse fragments. Thus we are able to judge by the sense of taste when our food has been chewed well enough and is ready to be swallowed.

What is the effect of temperature on the sensation of taste? If the temperature of food substances is widely different from the normal temperature of the mouth, the sense of taste may be very seriously affected. If a substance is extremely cold it produces a sensation of cold, which itself tends to deaden the sense of taste. On the other hand, if a substance is very hot it produces such a painful sensation as to check all sensation of taste. Thus if we put an exceedingly cold substance or an exceedingly hot substance into our mouths we lose the sensation of taste. It may be that the nerve of taste is active, but the sensation of taste is so obscured by the stronger sensation of heat or cold that the substance appears to lose all trace of taste.

Theoretically, the activity of the nerve of taste is at its best when the temperature of the substance to be tasted is the same as the

temperature of the mouth itself, or approximately ninety-eight and a half degrees. As a matter of fact, however, experience has shown that a somewhat lower temperature is better for a fine discrimination in taste. A temperature of from sixty-five to seventy-five degrees may be regarded as the best temperature for the activity of the nerves of taste.

Has the sense of taste any relation to good health? The sense of taste has a most important relation to health. It is the taste of a substance that to a great extent causes the secretion of the fluids which digest the food. A good taste tends to increase the activity of the glands that secrete these fluids. A bad or repugnant taste will produce entirely the opposite effect. So it is evident that the sense of taste bears a very important relation to health.

What is the effect of temperature on the wholesomeness of foods? The temperature of the food we eat has also an influence on health. Those who have trained the sense of taste and the sense of smell to perceive very delicate flavors, are extremely particular in regard to the temperature of their food and drink. In tasting red wine an expert taster requires the temperature of the wine to be about seventy-five degrees. On the other hand, most persons who have no knowledge of the nature of the

sense of taste desire their foods served at a very low temperature. This is true especially in the United States, where most families, even those in moderate circumstances, are able to keep ice during the summer.

There is a perfect mania, particularly in summer, for ice-cold drinks — water, lemonade, beer, buttermilk, and other beverages. We also have a great desire for ices and frozen dainties of all kinds and of all descriptions. But the laws of nature are very seriously abused when we take foods at so low a temperature. We are equally fond, especially in winter, of certain very hot drinks, thus going to the other extreme. In both cases the sense of taste is impaired, which is more or less injurious to health.

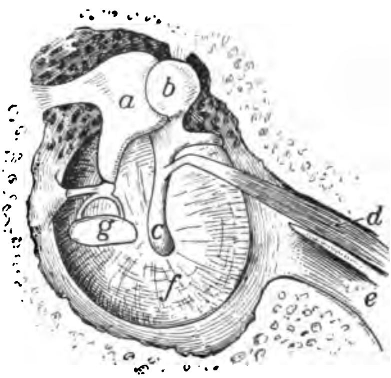
The lesson to be learned from these facts is that we should not eat foods above or below certain temperatures — cold foods not below fifty degrees, and warm foods not much above the temperature of the body. If we observe these precautions we can perhaps save ourselves from serious harm.

We should avoid the copious use of ice-cold drinks during the hot days of summer. Water is perfectly palatable at a temperature of from fifty to sixty degrees, while ice water has practically no taste whatever. Thus when we

go to extremes in temperature in our daily diet we not only lose a great deal of the pleasure of eating, but we injure our health.

THE SENSE OF HEARING

What is the auditory nerve? The *auditory* or hearing nerve is another path over which the knowledge of the outer world reaches the brain. The nerve of hearing transmits sounds to the brain. The external ear needs no description. Everybody knows what it looks like. But it is not so generally known that the opening in the ear does not extend very far into the head. It is closed a short distance in by a membrane which may be compared to the head of a drum. This membrane, stretched tight across the opening of the ear, is called the *tympanum* or *ear drum.* The external ear is divided from the middle or internal ear by this membrane.



The drum and bones of the ear

a, incus (anvil); *b*, malleus (hammer); *c*, handle of malleus; *d*, sensor tympani; *e*, Eustachian tube; *f*, tympanic membrane; *g*, stapes (stirrup)

The internal ear is connected with the throat by a tube called after the name of its discoverer

the *Eustachian* tube. This tube has a double purpose. Through it the middle ear may be kept properly moistened and lubricated, while at the same time it equalizes the pressure within and without.

Within the drum of the ear, lying still nearer the brain, is the middle ear where are spread the filaments of the auditory nerve. The sensation of sound is produced by the impact of vibrations in the air against the ear drum. Whenever a noise is made or a word is spoken vibrations are set in motion in the air which travel rapidly in all directions. If you pass by a pond in still weather, you will see that the surface is perfectly smooth. If you throw a pebble into the pond, ring-like waves of water will pass rapidly one after another from the point where the pebble struck the surface of the water, and proceed in circles at the same rate of speed in all directions.

Something of this kind happens in the air when a word is spoken. As a word emerges from the lips it strikes the external air and sets up a wave motion which travels in every direction. These waves strike every object within a certain radius and reach the ear drum of any person who happens to be within hearing distance. The air waves start a vibration in this membrane corresponding in character and

strength to their character and strength. This vibration is then transmitted along the auditory nerves to the brain, and the brain, in its mysterious working, sends us a message telling what the word is.

What is a phonograph? The word "phonograph" means sound writing. If you attach a feather to a membrane stretched like the head of a drum, and allow the point of the feather to rest on a piece of smoked paper or glass while you speak a series of words, and at the same time move the smoked plate, the feather will write in waving lines. This proves that the words you spoke caused a series of vibrations in the membrane. If instead of the feather you use a delicate needle with a sharp point capable of writing on wax, you have the basis of the phonograph.

In the phonograph you speak into a tube leading to the membrane. That membrane has a pen attached to it which rests upon a moving wax cylinder or plate. The waves of sound transmitted to the membrane cause the pen to write a waving line in the wax corresponding to the strength and character of the sound of the words you speak. In much the same way the vibrations in the drum of the ear are recorded, not on smoked glass nor on wax but in the brain itself.

In what particular way is sound transmitted from the ear drum to the brain? Immediately within the ear drum is a series of three small bones. The first touches the ear drum and rests on the second, and the second rests on the third. It is through these three little bones that the sound is started on its journey to the brain. They are all provided with muscles by means of which they can be tightened or loosened, in much the same way that a violin string is tightened or loosened by means of a peg. Thus the sensitiveness of the bones, that is, their power of transmitting the sound, may be increased or diminished by the action of the muscles attached to them.

These muscles adapt the transmitting apparatus of the ear to the special sound it is trying to interpret. The auditory nerve terminates in the ear in hair-like filaments or cells. These receive the vibrations transmitted by the small bones and muscles in contact with the *tympanum*, or ear drum, and send them inward toward the brain in very much the same manner that the nerve filaments on the retina of the eye transmit the vibrations of light. These numerous hair-like cells are arranged in quite regular rows and may be compared to the keys of an organ or a piano, though there are more than two rows. In fact, there is a very large number

of these organ keys; it is estimated that there are from twelve to twenty thousand. Thus it is evident that the complexity of the ear organ is far greater than that of the church organ.

What relation has the ear to health? The power to distinguish sound is one of the important means we have of knowing what is going on around us. For this reason it is evident that the sense of sound is of great importance to our welfare. The sense of sound often warns us of physical danger, so that we are able to avoid accidents or injuries which otherwise would befall us.

The ear is subject to certain diseases more or less injurious to our general health. Back of the ear is a portion of the skull, called the *mastoid* bone, which is spongy in character. In certain disorders of the ear this bone sometimes becomes affected, causing great pain and danger. The ear itself, with its various organs, is often subject to strain or inflammation. This causes earache, a troublesome disease. The tube leading from the ear to the throat, called the Eustachian tube, may also become infected as the result of colds or inflammations, and may even become clogged, a most dangerous condition.

The sense of hearing gives us many of the pleasures of life. The conversation of friends,

the notes of beautiful music, the strains of the distant orchestra, the song of the birds in the trees, the song of the cricket, the sound of running waters, all are pleasing and give us a feeling of happiness and contentment. In this way the sense of hearing helps to keep us in good health.

Are we able to locate the sources of sound? When we see an object we know exactly its location and can judge approximately its distance and its size. When we hear a sound we are not able to tell exactly where it came from. The source of a sound can to a certain extent be located, but with nothing like the accuracy with which a visible object can be located. People differ greatly in their ability to place the source of sounds.

How fast does sound travel? In the air sound travels about 1,100 feet per second; in solid bodies it travels much faster. I heard the cannonading at Fort Donelson on the 14th of February, 1862, while working in my father's maple grove nearly 200 miles away. Subsequent investigation showed that the sound had traveled through a layer of limestone. Sound may be carried much farther through solid bodies than through the air. You see the flash of the lightning some time before you hear the thunder.

THE SENSE OF TOUCH

What is meant by the sense of touch or feeling? If we close our eyes and place our hands on an object, a distinct sensation is experienced. The nerves that transmit this sensation to our brains are the nerves of touch or feeling. The moment our hands come in contact with an object we can determine, without looking at it, whether it is hard or soft, rough or smooth, round or angular, and whether it is hot or cold. Thus it is clear that the sense of touch or feeling is a very complicated sense into which enter a great many factors.

Some of the things that can be determined by the sense of touch alone, can also be determined by the sense of sight. For instance, the shape of an object, and whether it is rough or smooth, can easily be determined by looking at it as well as by feeling it. On the other hand, there are certain characteristics of an object which the touch cannot reveal—for instance, the color, and what taste or odor it may have.

Of all the senses, that of touch may be regarded as the most universal; that is, it gives us more information and of a more varied character than we can gain from any other set of nerves. But it cannot be regarded as the most desirable or pleasurable, though without doubt

it is the most useful. We may lose the sense of sight, of hearing, of taste, of smell, and still exist tolerably well, but should we lose also the sense of touch we should be utterly helpless. The case of Helen Keller is a remarkable instance of the possibility of obtaining a fine education through the sense of touch alone. Through illness she lost the senses of sight and hearing at a very early age, yet she has become a cultured and highly educated woman.

How is the sense of touch or feeling exerted? The nerves which carry the sensation of touch are located mostly in the skin. The skin has already been described as a very useful and necessary covering of the body. It can now also be described as the chief organ of touch. The skin is by no means the only part of the body that has nerves of touch. Such nerves are found also in the tongue and in the muscles and to a certain extent in the internal organs of the body, though in the latter they are greatly modified.

The best authorities declare that the various functions of the sense of touch are not carried on by the same nerve filaments. In other words, the sensation by means of which we get the outlines of a body and determine whether it is rough or smooth is carried by one kind of nerve filament, while the sense of cold, and of heat,

and of pain are each carried by other kinds of nerve filaments. These filaments are probably continuous—that is, they pass in bundles from the brain through the spinal cord and radiate from the spinal cord to all parts of the body, where the bundles break up into the separate filaments.

The skin itself is not perfectly smooth, as one might suppose, but is covered with numerous small projections or papillae, particularly on the scalp and often on the arms and other parts of the body. These papillae carry hairs which may be regarded as the advance guards of the nerves of touch. Anything coming in contact with one of these fine hairs is likely to stimulate the sense of touch.

The principal purpose of hair is protection, but it also has the secondary property of exciting, or tending to excite, the nerves of touch.

The nerves of touch vary in abundance in different parts of the body. They are very numerous in the hands, the feet, and at the tip of the tongue. They are more sparsely distributed over the skin of the arms, the neck, the back, and other portions of the body. There are more of these sensory points in the fingers and the tongue than in any other part of the body.

The remarkable skill that can be developed in the fingers results from the training or education of the nerve of touch. There are certain trades and professions in which this sense is developed to a most remarkable degree. To become skilled as a piano player, billiard player, watch maker, surgeon, or in other professions of similar character the sense of touch must be highly trained.

Are the internal organs supplied with nerves of touch or feeling? The nerves of feeling in the internal organs are few in comparison with the number in the skin. We do not have any pleasurable sensations in the internal organs. The nerves of feeling there mostly transmit feelings of pain. If there is anything wrong in the internal organs, the nerves send messages of pain to the nerve centers.

The brain is almost without nerves of sensation. Headaches are usually due to pain in the membranes or annexes of the brain.

When the appendix becomes inflamed we have severe pain, but the pain is due largely to the membranes which surround the appendix. The muscles also are endowed with sensations that are mostly sensations of pain, though in a much less degree. This is also true of the bones, the membranes of which are probably the most sensitive parts.

In general we may say that the nerves of sensation are distributed through all parts of the body, but are especially abundant in the skin and the mucous membranes.

Pain and pleasure. The nerves of touch which convey pain are perhaps the most numerous and abundant of all. It is, as we have said, difficult to prick the skin without touching a nerve conveying a sensation of pain. Just what form of vibration, or by what method of movement, the sensation of pain is communicated to the brain no one knows.

Painful sensations are of two kinds. Pressure or puncture of the skin produces one of the most common forms of pain. The sensation of cold is another kind of painful sensation. But the nerves that carry the sensation of cold are not so numerous as those that carry the sensation of other forms of pain.

Pleasurable sensations, on the other hand, are very difficult to define. Agreeable odors and tastes are types of pleasurable sensations carried by the special nerves of the nose and the tongue. Agreeable music produces a pleasurable sensation carried by the nerves of the ear. Landscapes and pictures and forests and streams produce pleasurable sensations carried by the nerves of the eye. The nerves of touch in the skin also convey pleasurable sensations, due largely to a

proper degree of warmth or gentleness of pressure on the skin. It is very difficult to describe these sensations, but we need appeal only to our own experience for a further knowledge of them. A person in good health and in an agreeable environment has that general sense of comfort so admirably expressed by the German word *Behagen*.

What relation has the sense of touch to our health and welfare? The sense of touch guards our health and comfort in many ways. The sensation of cold warns us against temperatures that would injure the tissues of the body and perhaps cause death. The sensation of heat likewise warns us from coming in contact with bodies hot enough to threaten injury to the structure of our bodily tissues. Pleasurable sensations tell us the proper temperature in which it is comfortable to live. In the winter we seek a temperature warm enough to prevent discomfort from cold and yet not hot enough to threaten health.

Sensations of pain teach us to avoid those things which experience tells us are nearly always harmful. Our sensations of pleasure teach us to seek those things that contribute to our welfare. Thus from every point of view the sense of touch is highly important in regard to our physical well-being.

Are we always able correctly to localize sensations of pain? If we have a pain we generally know where it is, though sometimes we cannot locate it correctly. The pain of a toothache sometimes seems to be not in the tooth really affected but in some other tooth. The pain in the eye or in the back of the head may not really be localized there, as we suppose. The sensations of pain are reported to the brain, but are not always referred by it to the exact locality.

It is a well-known phenomenon that years after persons have lost an arm they experience pains that are referred by the brain to the missing member. So a feeling of pain in a certain part of the body cannot always be regarded as a certain index that the trouble will be found there.

But as a rule we have little doubt as to where the trouble really is. In the case of pain in the internal organs we are more likely to be misled than in the case of pain in any exterior parts where the skin is the sensory medium.

How can the delicacy of touch and feeling be increased? The sensitiveness of the nerves of touch and feeling may be increased by constant and judicious use. Education in the ordinary sense of the word is the training we get from books and teachers in school; in other words,

it is a cultivation of the brain. To increase the delicacy and sensitiveness of the nerves of touch by constant and judicious use may be regarded as part of the education of the spinal cord.

The skill which can be acquired by educating the nerve of touch is extraordinary. If we listen to a master at the piano and compare what he does with the slow and clumsy efforts of the beginner, we have a vivid illustration of the cultivation of the sense of touch. The performance of practically all skilled hand work is controlled by the sense of touch. While this is not exclusively true, it is true as a general rule. The artist who paints a landscape judges the effect of the colors with his eye. But the distribution of the color to produce the artistic effect he desires is accomplished by movements controlled by the sense of touch, just as truly as the skillful piano player produces music by the sense of touch. The work of the skilled carpenter is another illustration of the result of educating the sense of touch. Such manual skill, due largely to the delicacy of the sense of touch, is called *technique*. Any intelligent person who examines the works of a watch can see how they are put together. But only one who has acquired an extremely fine sense of touch and delicate sense of movement can make a watch.

There is no form of labor that cannot be more efficiently performed after cultivating the sense of touch. From this we learn the great importance in our schools of courses in manual training, cooking, and sewing. One of the radical differences between the modern and earlier methods of instruction is the introduction of manual training of all kinds into our schools and colleges.

The microscope would probably not show any distinction between an educated tactile (touch) nerve filament and an uneducated one. But there must be some difference in the adjustment in order that a movement should be awkward when performed by the unskilled person and graceful when performed by the skilled.

Can one sense take the place of another? Nature has so endowed us that if one sense is impaired or destroyed the deficiency is made up to a certain degree through some other sense. The person who is blind practically may see with his fingers and ears. He can judge the form, contour, and surface of a body by means of the nerves of touch. He can learn to walk in comparative safety, finding his way by means of the sense of hearing. You have no doubt seen a blind man walking in the street constantly striking a stick on the pavement in front of him. The reflected sound of the tapping

tells him how near he is to the wall beside which he is walking. The pilot of a river boat may guide his boat safely in a fog by constantly blowing the boat's whistle, determining where he is in the stream by the echo from the surrounding hills.

A blind man walking in the street

The blind man may learn to read by means of his fingers. Passing his fingers over raised letters, he recognizes each letter by the sense of touch. By watching the lips of the person talking to him, the deaf man is able to understand speech through his eyes. He can tell from the movements of a person's lips just what letter or word is being spoken. Thus we see that in the person who has lost one sense the delicacy and intensity of the remaining senses is increased. A blind man may become highly educated in any branch of science or letters. In fact, a person may lose all his senses except one or two and still be able to get some idea of his environment. Helen Keller can neither see nor

hear, and yet she is a highly educated woman. Her knowledge of the world about her is conveyed to her through the nerves of taste, smell, and touch.

According to their comparative importance in giving us information about our environment, the senses may be arranged in the following order: sight, hearing, touch, taste, and smell. There may be some difference of opinion in regard to this arrangement, especially as to which is the more important, hearing or touch; but in my judgment this is the proper arrangement of the senses according to their value to us in our relations with the world.

The skilled pianist plays without glancing at the keyboard

What is the effect of training on the senses? The senses can be educated to a degree which seemingly is often beyond belief. The skilled typist operates her machine swiftly and accurately without looking at the keyboard. This

is also true of the skilled piano player. The billiard expert can make shots which to the unskilled player seem due to supernatural power. The skilled surgeon can thrust his knife among the vital parts of the body, cut out the offending organ, and save life in a way that seems due to almost more than human achievement. And so we might give instances of the remarkable degree of refinement and delicacy of which every sense is capable.

THE SENSE OF HUNGER

What is the sense of hunger? The sense of hunger is manifested chiefly in the stomach. But we cannot definitely locate this sensation as we can that of a burn or the prick of a needle. When we are hungry the general idea seems to be that the sensation is in the stomach. This sensation in a healthy person is caused by the stomach becoming empty. The feeling of hunger cannot be traced directly to a lack of nutrition of the body. In fact, six hours after eating, when the food has been digested and is just beginning to do its work in nourishing the body, we feel hungry. Thus it is not possible that the feeling of hunger arises directly from any lack of nutrition of the tissues of the body. It must be the result of the emptiness of the stomach. We must distinguish

between starvation and hunger. Starvation is a condition; hunger is a sensation.

In starvation the victim at first feels a very keen sense of hunger. After a while, as the starvation progresses the hunger diminishes, for the reason that the body has begun to burn itself or consume its own tissues. Emaciation is the result, weight and strength decrease, and finally the sense of hunger is subordinated entirely to the feeling of weakness and approaching death.

What relation has the sense of hunger to the proper control of our diet? The feeling of hunger does not stop immediately when we put food into our stomachs. If we eat rapidly the stomach may become well distended and still the sensation of hunger remain. For this reason we should eat slowly and stop eating before the sensation of hunger entirely disappears.

Every one of you must have noticed that if you eat a generous meal hurriedly you still feel hungry. But within half an hour after you leave the table, although you have eaten nothing more, the sense of hunger disappears. From this we learn, what it is wise to remember, that hunger disappears gradually. We will thus avoid distending our stomachs unduly with an overabundance of food in a useless effort to satisfy hunger quickly.

THE SENSE OF THIRST

What is the sense of thirst? Just as the stomach is associated with the feeling of hunger, so the *pharynx*, or throat, is associated with the sense of thirst. When we are thirsty it does not necessarily follow that the system has been deprived of water until health is threatened. Just as the sense of hunger is felt though there is no actual lack of nutrition of the tissues, so the sense of thirst is developed before any dangerous loss of water from the system takes place. If the weather is warm and we exercise vigorously, the amount of moisture lost from the body is increased, especially the amount lost by perspiration. Then in some way the need of the system for additional moisture is localized in the nerves of the throat and mouth. The back of the mouth becomes dry and the lips parched.

Thirst is more quickly satisfied than hunger. Drinking satisfies the sense of thirst within a few moments, long before the water can enter the circulation. This also proves that the sense of thirst is not due solely to the depletion of the water supply in the tissues of the body, because the feeling of thirst is satisfied long before the depletion can be remedied.

XXXI. A Study of Sleep

What is sleep? Sleep is a temporary suspension of the function of the senses that give us our knowledge of the world about us. The only difference between sleep and death is the continued activity of the muscles of the heart and the muscles used in breathing. The process of digestion also is active during sleep. But the muscles of the digestive organs, as well as those of the heart and those used in breathing, probably act less vigorously when we are asleep than when we are awake.

Can a human being live without sleep? Sleep is necessary to existence, but we may live for a long time without it. If a person remains in a state of complete repose, and has the will power to refrain from all physical or mental exertion, he may obtain the relief that naturally comes from sleep without actually going to sleep. The great purpose of sleep is to withdraw the body from all the stimuli of the natural world, so that the brain, the spinal cord, the nerves, and the muscles may rest. It is possible to rest without losing consciousness and thus partially compensate for loss of sleep. But the restoration of all the organs of the body to a condition suitable for further exertion is best

secured in sleep, by the complete obliteration of the external world.

How long should we sleep? The answer to this question depends upon several conditions. In early life a human being needs more sleep than he does in later life. The new-born infant sleeps nearly all the time. The baby of one year will sleep from twelve to fifteen hours a day. A child from one and a half to three years of age will sleep about twelve hours a day. From three to six years of age a child should sleep from nine to twelve hours a day; from the age of six to ten, from nine to eleven hours a day; and from ten to eighteen, from eight to nine hours a day. Regular hours for going to bed and getting up are important. The sleeping porch or at least the open window is desirable, and quiet and darkness favorable.

Sitting at the bedside of children and telling stories or singing lullabys is wholly out of place. A child soon learns that he goes to bed to sleep and not to be entertained by any kind of a vaudeville.

The amount of sleep for each person necessarily varies according to his occupation and his temperament. Some persons require, or at least indulge in, a longer period of sleep than others. A man or woman engaged in active work requires a minimum of seven hours' sleep,

while eight hours would be better. The length of time a person sleeps is not the only thing to be kept in view; the character of the sleep itself is also important. The more peacefully a person sleeps, the fewer are the number of hours required. On the other hand, if sleep is troubled with frequent wakings, twitchings, and movements of the arms and legs, it is less refreshing, and more hours are required.

The man who engages in hard physical labor needs more sleep than the one engaged at desk work. Brain workers probably need less sleep than muscle workers, but they too need peaceful and refreshing sleep in order that the brain may recuperate and gather energy for further activities.

What happens when a person does not get enough sleep? If a person gets too little sleep, various disorders may result. These are manifested chiefly through increased sensibility and irritability, a diminished power of endurance, and decreased strength and vitality. These changes, with continued loss of sleep, may even make it difficult to sleep at all.

What is insomnia? *Insomnia*, or sleeplessness, is the inability to go to sleep when there is opportunity to do so. Insomnia is one of the most distressing disorders. It is not so trying during the day, when the light is bright and we

are mingling with companions; but it is terribly depressing to lie alone in the dark and not be able to go to sleep.

The wear and tear on the nervous system is extremely great in such circumstances, and when morning comes the sleepless one rises with his brain dazed, a general indisposition to engage in work or activity of any kind, and usually with little or no appetite.

If sleeplessness becomes chronic, it may develop disorders of the brain and promote *neurasthenia*, or nerve troubles. Moreover, insomnia may diminish the power of the body to resist infectious or contagious disease. Sleeplessness also tends to promote an early beginning of the diseases of old age, such as hardening of the arteries and diseases of the heart and of the kidneys.

Do people ever sleep too much? There are many persons who indulge in a greater amount of sleep than they actually require. Too much sleep, while not so harmful as too little sleep, is nevertheless injurious. A person who sleeps too much becomes dull and sluggish both physically and mentally, and may so weaken the power of his body to resist disease as to fall an easy victim. Usually such a person lacks energy and does not take much exercise so he is also likely to become too fat.

Sleep, like food, is necessary to existence. But too much sleep or too little sleep is harmful. As in all other things, temperance in sleep is highly advisable.

When is a person inclined to sleep too much, likely to have the greatest inclination to sleep? After eating a hearty meal such a person usually has a feeling of lassitude and sleepiness. During sleep the brain is not so active as during the waking hours. A heavy meal excites the digestive activities and thus diverts a considerable quantity of blood from the brain and other parts of the body to the digestive organs. In this way a heavy meal, especially if the room is warm, brings about the same conditions as in sleep, and induces a desire for sleep. After a hearty meal, especially in summer, almost any one feels an inclination to sleep. In a church or a theater in the evening we often find many in the audience nodding. If we ask the reason we usually find that these persons have just eaten a heavy meal. The result is anything but pleasant, for the sleeper often snores loudly, much to the embarrassment of those near him. If we wish to be wide awake in the evening, we should not eat a heavy meal late in the day.

Should we exercise immediately after eating? Whenever it is possible, the hour immediately following the meal should be devoted to rest,

even if that rest induces sleep. In fact, those who have the leisure to do so would benefit by giving way to the desire to sleep after a meal. To take a nap after his noonday meal is conducive to a child's health. The health of grown people would also be improved if they could sleep for fifteen or thirty minutes after the noonday meal. Unfortunately, most people have no opportunity to indulge this desire to sleep. For this reason they should eat so moderately as to make the inclination less strong.

What changes take place in the circulation during sleep? When a person is asleep the heartbeats are slower and there is a slight decrease in the natural heat of the body. But the temperature of the brain is apparently not decreased to any extent. Some physiologists believe that there is more blood in the brain during sleep than during waking hours. Most physiologists, however, speak of the condition of the brain during sleep as *anemic*, that is, having less blood in it. If there be more blood in the brain during sleep it is apparently due solely to physical causes. When we are awake we are usually in an erect position, and the blood has to reach the brain against the force of gravity; if we are lying down the blood of course reaches the brain with less resistance. But it is not necessary to lie down to sleep. Many of us realize only too keenly how

easy it is to go to sleep sitting up, especially if we are seated in a crowded room and not greatly interested in what is going on.

What other effect has sleep on the functions of the body? The digestive and assimilative powers of the body are probably increased during sleep. The breathing becomes slower, and often deeper. Sometimes, when the nasal passages are obstructed in any way and the mouth is open, snoring results. If you keep your mouth shut you will not snore.

Some experimenters think that there is an accumulation of carbon dioxide in the blood, and that this is either the cause or the result of sleep. It is well known that the amount of carbon dioxide excreted from the lungs is less during sleep than during the waking hours.

Sleep is profoundly influenced by habit. If we are in the habit of going to sleep at a certain hour we are very apt to become weary and have all the symptoms of sleepiness when that hour comes. If we postpone our sleep beyond the regular hour we do not as a rule become more sleepy; for a time the feeling of sleepiness diminishes. If a person who is in the habit of going to sleep at ten o'clock in the evening is kept up until midnight, or one o'clock in the morning, he then usually has great difficulty in falling asleep.

Usually physical fatigue is supposed to induce sleep. But we may be so tired that we cannot sleep. Most people are in the habit of sleeping at night, when it is dark, and thus are not able to sleep in daylight or if there is a brilliant light in the bedroom.

Perhaps the best way to explain sleep is this: Sleep naturally follows wakefulness, just as the night follows the day. We sleep because it is natural, and we wake because it is natural.

How long can a person live without sleep? How long a person can live without sleep can be determined only by experimental methods that are very cruel and for that reason little is known about it. The only way animals or human beings can be kept from sleep is to torture them so that the pain produced is stronger than the desire for sleep. Then, if this torture is kept up until death occurs, who can say whether death was caused by lack of sleep or by an excess of pain?

A person in good health may lose one night's sleep without apparent injury, but he cannot lose a second night's sleep without some loss of efficiency. Prolonged sleep is much less injurious than prolonged wakefulness, though prolonged sleep is the sign of some grave disorder or change in the activity of the func tions of the body, usually of a cerebral (brai n

character. When an animal cannot be aroused by the usual methods, it has passed into what is called a state of *coma*, which usually ends in death.

Are there other kinds of sleep besides natural sleep? Sleep may be induced by various artificial means. Artificial sleep is most commonly induced by means of a drug. The drugs which induce sleep are called *narcotics*. Opium and morphine are types of narcotic substances.

Is there any danger in using such drugs? There is great danger in using drugs of this kind. They can be given safely only by a physician who has personal supervision of the patient. The use of many of these narcotics, especially opium and its derivatives — morphine, heroin, and codein — and cocaine tends to produce a habit which, when once formed, is very difficult to break, and gradually destroys both physical and mental health.

Opium and its derivatives deaden pain, and their use is excusable when there is no chance for the patient to get well. But so long as there is a chance for the patient to recover it is far better never to administer any of these temporary reliefs than to cause him to form a habit which, after he recovers from the disease, is certain to destroy him.

Are there any laws to restrict the sale of such drugs? There is a national law which restricts

trade in opium and coca leaves and their derivatives, morphine and cocaine. The derivative of the coca leaf is the drug known as cocaine. Cocaine is not a sleep-producing drug, but it has the remarkable ability of relieving pain and of inducing a condition of emotional excitement. It is even more of a habit-forming and destructive drug than morphine, and its victims are utterly miserable when deprived of it. There is no more dreadful form of starving than to be a morphine or cocaine addict.

Opium and its compounds, and coca leaves and their derivatives, of which cocaine is the only one of importance, cannot be sold in this country except under strict regulations, which require registration and accounting on the part of those dealing in them. Most of the states have strict laws regulating the sale of these dangerous habit-forming drugs, and in many cities there are municipal laws to the same effect. Children, especially, should be protected from the evils which always attend the use of such drugs.

Is artificial sleep, induced by means of drugs, beneficial? As far as rest or restored energy is concerned, the sleep induced by the use of a narcotic gives very little of the benefit that comes from natural rest or real slumber. The drug relieves pain, but the possible harmful

after-effect when the patient recovers is far greater than the good it does in relieving pain. But the use of narcotics is merciful in the treatment of cases that are hopeless and in easing the pain of the last hours of life.

What other kinds of sleep are there? There are certain conditions of unconsciousness in which the patient is apparently asleep, though the sleep is totally different in character from real sleep. *Hypnotism* is a form of sleep in which the sleeper is subject to the will of another. No one can explain the mystery of hypnotic sleep. The person who is under the influence of hypnotism is oblivious of all surroundings except as determined by the person who has placed him under that influence. The hypnotist commands, and the hypnotic obeys involuntarily. The hypnotic answers questions sensibly, performs acts of all kinds, and in general does any work assigned to him in a satisfactory manner. When he is recalled from the hypnotic trance by the will of the hypnotist he has no memory of what has taken place. In a way it may be said that he has been asleep, though hypnotic slumber is as different from real sleep as the sleep induced by the use of opium.

What is meant by sleep walking? The person who walks in his sleep, often acting exactly as

if he were awake, is called a *somnambulist*, a word derived from two Latin words, *somnus*, meaning "sleep," and *ambulare*, meaning "to walk about." The somnambulist gets up from his bed, goes about the house, sometimes performs wonderful feats of athletic skill, and does

A somnambulist

many things better than he could if he were awake. When he is awakened he has no recollection of anything that has happened. People who walk in their sleep often suffer serious injury by falling or running into things.

Nearly everybody now and then makes some

movement in his sleep, crying out or talking, or sitting up, or gesticulating. These actions are usually remembered as taking place in dreams. But the somnambulist remembers nothing that occurred in his walk. Certain individuals are more subject to sleep walking than others. No positive remedy has been discovered for this unpleasant affliction. As a general thing simple food, outdoor exercise, light, clothing, and regular habits will diminish the tendency to sleep walking and sometimes prevent it altogether.

What is meant by being in a trance? Persons who are in a trance are asleep in the sense that they have lost consciousness of the external world. But their brains often remain active. People in a trance write letters, answer questions, and do many things that they would perhaps not be able to do if they were in a normal condition.

There is another form of sleep in which the body is more or less rigid, sometimes remaining in this condition for many hours or even days. This form of sleep is called *catalepsy*. This condition is, of course, abnormal, and seems to have no relation whatever to natural sleep. In other words, it is a disease.

Is sleep very important? When we consider that in a normal life of seventy years we pass

nearly twenty-three years in sleep, it is evident that sleep is very important in its relations to our welfare. We are just as much alive while asleep as we are while awake, but it is a different kind of life. Sleep is a vegetative life, growth, restoration of tissues, rebuilding of the broken parts of the system, rest and refreshment. From a physical point of view, sleep is quite as important as food and much more so than clothing. The fact that we spend almost one third of our lives asleep should impress us with the importance of sleep. Sleep is essential to the health of the body. The hours of sleep should therefore be ordered as carefully as the hours of work or of play.

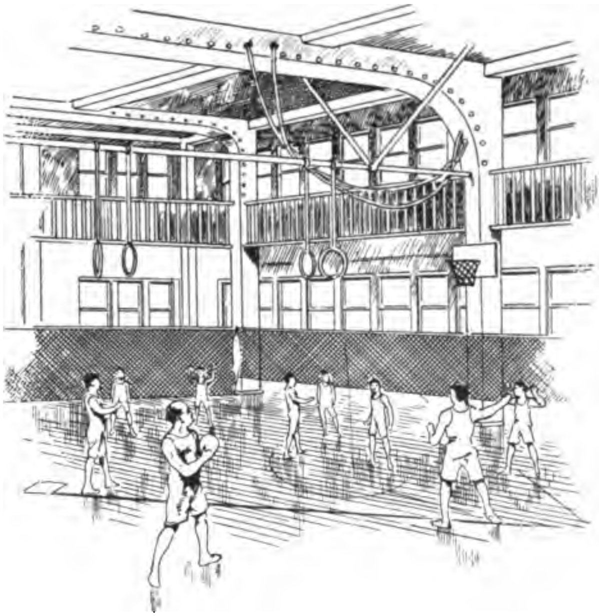
XXXII. Physical Exercise

What is the value of special physical training? Ordinarily the child who plays out of doors will become thoroughly developed physically. The muscles of the legs are developed by walking and running, and the muscles of the arms by playing ball, drawing carts, and other play activities. The deep and rapid breathing which vigorous play induces will develop the muscles of the thorax. Thus most of the child's muscles become developed in play. It is advisable, however, to aid and direct such development scientifically and to provide special exercise for certain needs. For this reason the gymnasium is an important adjunct of the playground.

The gymnasium. The gymnasium is, as a rule, a closed building where exercise can be taken during very cold weather, in rainy seasons, and even at night. Thus the gymnasium provides a place where the important process of physical development may be carried on in spite of outdoor conditions that would prevent it.

Are gymnastic exercises of value? The value of gymnastic exercises cannot be denied. Though conducted within doors, such exercises, if properly directed and if the gymnasium is properly ventilated, are very beneficial. But the boy

in the gymnasium needs supervision; in other words, his exercises must be performed under the direction of a teacher. To turn children loose in a gymnasium without any supervision or instruction with regard to the use of the



Interior of a gymnasium

various appliances found there might do more harm than good.

The instructor or supervisor should endeavor especially to prevent excessive physical exertion. Physical exercises are of value in proportion to their judicious use. An unusual strain or

fatigue in the muscles of the body as a result of too much exercise is harmful instead of beneficial.

Kinds of exercises. In the gymnasium, children should at first go through very simple exercises. The exercises should gradually increase in intensity as the muscular system develops and endurance increases. Thus, by gradual training the child may learn to go through with ease exercises which he would otherwise have been unable to perform.

When properly equipped, the gymnasium is supplied with many different kinds of apparatus for physical development. Running, jumping, swinging, climbing, the swinging of Indian clubs, vaulting, and many other exercises are included in the general course of instruction. The attendant should always take care to have the gymnasium well ventilated and at the proper temperature. The temperature in the gymnasium should always be lower than would seem agreeable for any one not engaged in active exercise. While the temperature in the living room should be sixty-eight to seventy degrees, the temperature in the gymnasium may properly be as low as sixty to sixty-five degrees. For exercises on the trapeze, or for any other exercises in which there is danger of falling, padded floors or cushions should be provided.

A detailed description of the particular forms of exercises which should be practiced in the gymnasium cannot be given here. The wise and scientific superintendent will study the particular needs of each child and try to give him exercises in accordance with those needs. Children become very fond of gymnastic work when it is properly conducted. Its good effects are visible in hardened muscles, clearer eyes, greater mental activity, and increased physical endurance.

What is the value of competitive games? In play, as in business, healthful competition is beneficial. Games are better than ordinary play because of the added zest induced by the desire to win a victory. The sport of simply throwing or batting a ball is pleasant exercise, but it can in no way equal the interest of a game of ball in which each side is struggling for the victory. For this reason competitive games in the gymnasium or in the open field, under good supervision, are effective in promoting physical development.

Are such games dangerous? There is one danger to be avoided in such games. During the crises of competitive play the players put forth supreme efforts. Such efforts result in excessive strain or fatigue. Some games are much more dangerous on this account than others. First

among such games is football, though there is scarcely any game in which a child will take part with more enthusiasm. For children, the modified Rugby variety of football is preferable to the game played by college and university students. In football, supreme physical exer-

Playing lawn tennis

tion is necessary, at least for a few moments at a time, in order to win the victory.

Competitive games with less danger to the child are baseball, basket ball, and lawn tennis. Tennis, especially, affords excellent physical training, and without any very great danger of overexertion. Baseball is a national sport, and every boy will want to learn to play it. It is comparatively safe, full of interest, and requires

much skill. Every child should be encouraged to play baseball or some modified form of it.

Are running games the proper thing for children? Running competitive games are interesting, but they require probably a greater degree of physical exertion than any other sport. There is danger to the heart and the organs of circulation in the supreme efforts put forth to win.

A few years ago almost everybody rode the bicycle for pleasure. Bicycle riding is delightful and beneficial, but when long runs at a rapid rate of speed are made, as in racing, extreme fatigue and great injury may result. In general, competitive games are to be encouraged, but always with wise supervision. Moments of extreme exertion should be few and far between and not long continued.

XXXIII. The Value of Health

What is the value of health? Children as a rule do not realize the money value of health. They realize its advantages, its freedom from pain, its exuberance, and the opportunity it gives them for enjoying life. But they do not realize that good health is also to be measured in dollars and cents. The mental efficiency of the child and of the grown person depends more largely on good health than on anything else. Progress in school and in college depends to a great extent on the health of the individual. Success in the office or in the shop depends very largely on good health. The value of a citizen to the community and to his own family and friends is greater or less according to his state of health. It is therefore a matter of supreme importance for every one to know from his earliest years the fundamental facts of nutrition, of exercise, and of play, in order to secure a maximum of good health in childhood as well as in adult life.

How is sickness costly? Just as we may regard good health as an increase in money value and usefulness, so may we measure ill health as a loss in money value and efficiency. The sick person is not only unable to do useful and

lucrative work, but he is also a burden of care to his family. The cost of professional medical service is often very great. Sickness is therefore a heavy burden on humanity, and we should do everything in our power to avoid it or to remove it when once it has befallen us.

To be sick is to be useless. From whatever point of view we look at the matter, it pays to keep well, and it costs a lot of money to be sick.

The object of study. The object which the child has in view, or at least which the parents have in view, during schooldays, is that he or she shall become a useful man or woman. Every factor in the training and conduct of the child which leads to this result is to be favored and promoted. Every obstacle which lies in the way of the achievement of this result is to be removed if possible.

Child life, from the physical point of view, has too long been neglected. To be healthy, well developed, and vigorous is not only the privilege but also the duty of every child. The harmonious development of all the organs of the body in the healthy child promotes the best development of the intellect and of the moral nature.

The purpose of writing this health reader has been to lead the child little by little into a knowledge of those things which concern his

physical welfare, realizing that this is intimately related to his mental and moral welfare. The child who has read and carefully studied the principles laid down in this book is for that reason better prepared to attain health, happiness, and success in life than he would otherwise have been.

A PRONOUNCING VOCABULARY

abdomen (ăb dō'mĕn).
absinthe(ăb'sĭnth).
albumin (ăl bū'mĭn).
alkali (ăl kȧ lī).
alkaline (ăl'kȧ lĭn).
alkalinity (ăl'kȧ lĭn'ĭ tĭ).
alkaloids (ăl'kȧ loids).
ambulare (äm bōō lä'rā).
amino (ăm'ĭ nō).
amylase (ăm'ĭ lās).
anemia (ȧ nē'mĭ ȧ).
Anopheles (ȧ nŏf'e lēz).
antiseptic (ăn'tĭ sĕp'tĭk).
apparatus (ăp'ȧ rā'tŭs).
appendicitis (ă pĕn'dĭ sī tis).
aqueous (ā'kwė ŭs).
argon (är'gŏn).
aroma (ȧ rō'mȧ).
artesian (är tē'zhăn).
articulate (är tĭk'ū lȧt).
astigmatism (ȧ stĭg'mȧ tiz'm).
auditory (ô'dĭ tô rĭ).

bacteriologist (băk tē'rĭ ŏl'ô jĭst).
barometer (bȧ rŏm'ė tĕr).
Behagen (bā hä'gĕn).
benzoate (bĕn'zô āt).
beri-beri (bĕr'i-bĕr'ĭ).
beverage (bĕv'ĕr ȧj).
bolus (bō'lŭs).
bronchitis (brŏn kī'tĭs).

caecum (sē'kŭm).
caffeine (kăf'ė ĭn; ēn).
calcium (kăl'sĭ ŭm).
canine (kȧ nīn').
capillaries (kăp'ĭ lȧ rĭ;
kȧ pĭl'ȧ rĭz).
Capsicum (kăp'si kŭm).
carbohydrate (kär'bô hi'drāt).
carbon dioxide (kär'bŏn).
dī ŏk'sīd).
cardiac orifice (kär'dĭ ăk ŏr'ĭ fĭs).
cartilage (kär'tĭ lȧj).
casein (kā sė ĭn).

cassava (kă sä'vȧ).
catalepsy (kăt'ȧ lĕp' sĭ).
catarrh (kȧ tär').
cellulose (sĕl'ū lōs).
cereal (sē'rė ăl).
cerebral (sĕr'ė brăl).
cervical (sûr'vĭ kăl).
champagne (shăm pān').
chlorine (klō'rin; rēn).
cholera (kŏl'ĕr ȧ).
citric (sĭt'rĭk).
citrus (sĭt'rŭs).
clinic (klĭn'ĭk).
coagulate (kô ăg'ū lāt).
cocaine (kō'kȧ ĭn).
codein (kô dē'ĭn).
colon (kō'lŏn).
coma (kō'mȧ).
competitive (kŏm pĕt'ĭ tĭv).
condiments (kŏn'dĭ mĕnts).
congestion (kŏn jĕs'chŭn).
conscious (kŏn'shŭs).
constituents (kŏn stit'ū ĕnts).
contagious (kŏn tā'jŭs).
contralto (kŏn trăl'tō).
convalescence (kŏn'vȧ lĕs'ĕns).
copious (kō'pĭ ŭs).
cornea (kôr'nė ȧ).
corpulent (kôr'pū lĕnt).
corpuscle (kôr'pus 'l).
crystalline (krĭs'tăl ĭn; īn).
culex (kū'leks).
cuticle (kū'tĭ k'l).

depletion (dė plē'shŭn).
dermis (dûr'mĭs).
deteriorate (dė tē'rĭ ô rāt).
dextrin (dĕks'trĭn).
dextrose (dĕks'trōs).
diabetes (dī'ȧ bē'tēz).
diaphragm (dī'ȧ frăm).
diastase (dī'ȧ stās).
dietetics (dī'ė tĕt'ĭks).
dioptric (dī ŏp'trĭk).
diphtheria (dĭf thē'rĭ ȧ).

dorsal (dôr'săl).
duodenum (dū'ō dē'nŭm).
dysentery (dĭs'ĕn tĕr ĭ).
dyspepsia (dĭs pĕp'sĭ ȧ; shȧ).

eau de Cologne (ō dē kō lōn').
edible (ĕd'ĭ b'l).
efficiency (ĕ fish'ĕn sĭ).
emulsion (ė mŭl shŭn).
entomology (ĕn'tō mŏl'ō jĭ).
environment (ĕn vī'rŭn mĕnt).
enzymes (ĕn'zīmz).
Epernay (ā pĕr'nĕ').
epidemic (ĕp'ĭ dĕm'ik).
epidermis (ĕp'ĭ dûr'mĭs).
epiglottis (ĕp'i glŏt'ĭs).
eradicate (ė răd'i kāt).
esophagus (ė sŏf'ȧ gŭs).
eucalyptus (ū'kā lĭp'tŭs).
Eustachian (ū stā'kĭ ăn).
excretion (ĕks krē'shŭn).
excretory (ĕks'krė tō rĭ).
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fatigue (fȧ tēg').
feces (fē'sēz).
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fibrous (fī brŭs).
filaments (fĭl'ȧ mĕnts).
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function (fŭŋk'shŭn).

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germicide (jûr'mĭ sīd).
gesticulate (jĕs tĭk'ū lāt).
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glucose (glōō'kōs).
gluten (glōō'tĕn).
glycerine (glĭs'ēr ĭn).
glycogen (glī'kō jĕn).
granary (grăn'ȧ rĭ).
graphite (grăf'īt).
gullet (gŭl'ĕt).
gustatory (gŭs'tȧ tō rĭ).

Hawaiian Islands (hä wī'yăn ī lănd).

heroin (hė rō'ĭn).
hordein (hôr'dė ĭn).
hydrochloric (hī'drō klō'rĭk).
hydrogen (hī'drō jĕn).
hypnotism (hĭp nō tĭz'm).

ileo-cæcal (ĭl'ė ō sē'kăl).
ileum (ĭl'ė ŭm).
incisors (ĭn sī'zērz).
indol (ĭn'dōl).
infectious (ĭn fek'shŭs).
insomnia (ĭn sŏm'nĭ ȧ).
intestines (ĭn tĕs'tĭnz).
iris (ī'rĭs).

jejunum (jė jōō'nŭm).
juniper (jōō'nĭ pēr).

krypton (krĭp'tŏn).

lacteal (lăk'tė ăl).
lactose (lăk'tōs).
lager (lä'gēr).
larynx (lăr'ĭŋks).
levulose (lĕv'ū lōs).
ligament (lĭg'ȧ mĕnt).
lipase (lĭp'ās).
lobule (lŏb ūl).
lubricate (lū'brĭ kāt).
lucrative (lū'krȧ tĭv).
lumbar (lŭm'bȧr).
lymphatic (lĭm făt'ĭk).

magnesia (măg nē'zhĭ ȧ).
maize (māz).
malaria (mȧ lā'rĭ ȧ).
malic (mā'lĭk; măl'ĭk).
malnutrition (măl'nū trish'ŭn).
maltose (môl'tōs; mŏl').
masticate (măs'tĭ kāt).
mastoid (măs'toid).
medicinal (mė dĭs'ĭ năl).
menthol (mĕn'thōl).
mercurial (mēr kū'rĭ ăl).
microbes (mī'krōbz).
microscopic (mīk'rō skŏp ĭk).
morphine (môr'fĭn; fēn).
mucous (adj.), (mū'kŭs).
mucus (noun), mū'kŭs).
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muscle (mŭs''l).
mythological (mĭth'ō lŏg'ĭ kăl).

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nasal (nā'zăl).
nectar (nĕk'tär).
nephritis (nē frī'tĭs).
neurasthenia (nū'răs thē'nĭ ȧ).
nicotine (nĭk'ō tĭn; tēn).
nitrogen (nī'trō jĕn).
nitrogenous (nī trŏj'ē nŭs).
nostril (nŏs'trĭl).
noxious (nŏk'shŭs).
nutrients (nū'trĭ ĕnts).

obesity (ō bĕs'ĭ tĭ).
odor (ō'dēr).
olfactory (ŏl făk'tō rĭ).
opaque (ō pāk').
opium (ō'pĭ ŭm).
optic (ŏp'tĭk).
oxidizing (ŏk'sĭ dīz'ĭng).
oxygen (ŏk'sĭ jĕn).

palate (păl'āt).
pancreas (păŋ'krē ăs).
papillae (pȧ pĭl'ē).
paralysis (pȧ răl'ĭ sĭs).
parasites (păr'ȧ sīts).
parotid (pȧ rŏt'ĭd).
pecan (pē kăn').
pellagra (pĕ lăg'rȧ).
percolate (pûr'kō lāt).
peroxide (pĕr ŏk'sīd).
perspiration (pûr'spĭ rā'shŭn).
petroleum (pē trō'lē ŭm).
pharynx (făr'ĭŋks).
phenol fē'nōl).
phagocytes (făg'ō sīts).
pharynx (făr'iŋks).
phosphate (fŏs'fāt).
phosphoric acid (fŏs fŏr'ĭk ăs'ĭd)
phosphorus (fŏs'fŏr ŭs).
plasma (plăz'mȧ).
pleura (ploo͞'rȧ).
pneumonia (nū mō'nĭ ȧ).
pollen (pŏl'ĕn).
porcelain (pôr'sē lān).
porous (pō'rŭs).
precipitate (prē sĭp'ĭ tāt).

protein (prō'tē ĭn).
ptyalin (tī'ȧ lĭn).
pungency (pŭn'jĕn sĭ).
pupa (pū'pȧ).
pylorus (pĭ lō' rŭs).

quartz (kwôrts).
quinine (kwī'nīn).
quotient (kwō'shĕnt).

rancid (răn'sĭd).
rectum (rĕk'tŭm).
recuperate (rē kū'pĕr āt).
refrigeration (rē frĭj'ēr ā'shŭn).
register (rĕj'ĭs tēr).
rennet (rĕn'ĕt).
respiratory (rē spīr'ȧ tō rĭ).
retina (rĕt'ĭ nȧ).
Rheims (rēmz).
rigid (rĭj'ĭd).
Rio de Janeiro (rē'ō zhȧ nā'rō).
ruminant (roo͞'mĭ nănt).

sago (sā'go).
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salivary (săl'ĭ vā rĭ).
sarcophagus (sär kŏf'ā gŭs).
sarsaparilla (sär'sȧ pȧ rĭl'ȧ).
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sensory (sĕn'sō rĭ).
serum (sē'rŭm).
skatol (skăt'ōl; ŏl).
soluble (sŏl'ū b'l).
solvent (sŏl'vĕnt).
somnambulist (sŏm năm'bū lĭst)
somnus (sŏm'nŭs).
soprano (sō prā'nō).
sorghum (sôr'gŭm).
spasmodic (spăz mŏd'ĭk).
sputum (spū'tŭm).
steapsin (stē ăp'sĭn).
stegomyia (stĕg'ō mī'yȧ).
sterile (stĕr'ĭl).
sterilize (stĕr'ĭ līz).
sternum (stûr'nŭm).
stimuli (stĭm'ū lī).
stimulus (stim'ū lŭs).
sublingual (sŭb lĭn'gwăl).
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succulent (sŭk'ū lĕnt).

suicide (sū′ĭ sīd).
sulphur (sŭl′fŭr).

tactile (tăk′tĭl).
tannin (tăn′ĭn).
taro (tä′rō).
tartaric (tär tăr′ĭk).
technical (tĕk′nĭ kăl).
technique (tĕk′nēk).
theine (thē′ĭn; ēn).
theobromine (the′ō brō′mĭn).
Theobroma cacao (thē′ō brō′mȧ kȧ kā′ō).
thoracic (thō răs′ĭk).
thorax (thō răks).
tissue (tish′ū).
tonsils (tŏn′sĭls).
trachea (trā′kē ȧ).
trypsin (trĭp′sĭn).
tubercle bacillus (tū′bĕr k′l bȧ sĭl′ŭs).
tuberculosis (tū bĕr′kū lō′sĭs).
tympanum (tĭm′pȧ nŭm).

urea (ū′rē ȧ).
ureter (ū rē′tĕr).
urethre (ū rē′thrȧ).
uric (ū′rĭk).
urine (ū′rĭn).
uvula (ū′vū lȧ).

vacuum (văk′ū ŭm).
vascular (văs′kū lȧr).
velocity (vē lŏs′ĭ tĭ).
venous (vē′nŭs).
vertebrae (vûr′tē brē).
villi (vĭl′ī).
viscid (vĭs′ĭd).
vitreous (vĭt′rē ŭs).
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whooping cough (hōōp′ĭng kôf).

xenon (zĕn′ŏn).

zein (zē′ĭn).

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